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USAF BIOENVIRONMENTAL NOISE DATA HANDBOOK VOLUME 65. T-37B AIRCRAFT, NEAR AND FAR-FIELD NOISE

AEROSPACE MEDICAL RESEARCH LABORATORY, WRIGHT-PATTERSON AIR FORCE BASE, OHIO

NOVEMBER 1975



USAF BIOENVIRONMENTAL NOISE DATA HANDBOOK

Volume 65 T-37B AIRCRAFT, NEAR AND FAR-FIELD NOISE

NOVEMBER 1975



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The USAF T-37B aircraft is a flight trainer powered by two J69-T-25 turbo-jet engines. This report provides measured and extrapolated data defining the bioacoustic environments produced by this aircraft operating on a concrete runup area for three power conditions. Near-field data are reported for four locations in a wide variety of physical and psychoacoustic measures: overall and band sound pressure levels, C-weighted and A-weighted sound levels, preferred speech interference level, perceived noise level, and limiting times for

total daily exposure of personnel with and without standard Air Force ear protectors. Far-field data measured at 19 locations are normalized to standard meteorological conditions and extrapolated from 75-8000 meters to derive sets of equal-value contours for these same seven acoustic measures as functions of angle and distance from the source. Refer to Volume 1 of this handbook, "USAF Bioenvironmental Noise Data Handbook, Vol 1: Organization, Content and Application", AMRL-TR-75-50(1) 1975, for discussion of the objective and design of the handbook, the types of data presented, measurement procedures, instrumentation, data processing, definitions of quantities, symbols, equations, applications, limitations, etc.

PREFACE

This report was prepared by the Biodynamic Environment Branch, Aerospace Medical Research Laboratory, under Project/Task 723104, Measurement of Noise and Vibration Environments of Air Force Operations.

The author gratefully acknowledges Mr. John Cole for his assistance in preparing this report, Mr. Robert England for his assistance in acquiring the raw data, Mr. Henry Mohlman and Mr. David Eilerman of the University of Dayton for assistance in the mechanics of data processing and Mrs. Norma Peachey and Mr. Mike Patterson for assistance in typing and preparation of the graphics.

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INTRODUCTION

The USAF T-37B is a trainer-type aircraft to teach all techniques and maneuvers of fighter aircraft and is powered by two J69-T-25 turbojet engines. The aircraft was manufactured by the Cessna Company and the engines by the Continental Aviation and Engineering Corporation.

This volume provides measured and extrapolated data defining bioacoustic environments produced by this aircraft during ground runup operations. Such data are essential to evaluate ear protection requirements, limiting personnel exposure times, voice communication capabilities, and annoyance problems associated with ground runups of the T-37B aircraft.

This volume is one of a series published by the Aerospace Medical Research Laboratory (AMRL) under the same report number (AMRL-TR-75-50) as a multi-volume handbook that quantifies the noise environments produced at flight/ground crew locations and in surrounding communities by operations of Air Force aircraft and aerospace ground equipment. The far-field, community-type noise data in the handbook describe the noise produced during ground operations of aircraft, aerospace ground equipment, and other ground-based equipment or facilities.

Volume 1 of this handbook discusses the objectives and design of the handbook, the types of data presented, measurement procedures, instrumentation, data processing, definitions of quantities, symbols, equations, applications, limitations, etc. Volume 2 provides a method and data for adjusting the handbook's far-field noise data, which are for standard meteorological conditions (15°C temperature, 70% rel humidity, 0.760 meters Hg barometric pressure), to derive comparable data for other meteorological conditions. Refer to Volumes 1 and 2 (references 1 and 2) for such information because it is not repeated in other handbook volumes.

A cumulative index lists those aerospace systems contained in the handbook, and identifies the specific volumes containing each type of environmental noise data available (i.e., inflight/flight crew and passenger noise, near-field/ground crew noise, far-field/community noise). Volume numbers are assigned sequentially as individual volumes are published. This index is periodically updated as individual volumes are published and is available upon request from AMRL/BBE, Wright-Patterson AFB, OH 45433. Organizations on the distribution list for the handbook will automatically receive a copy of each updated index.

Direct any questions concerning the technical data in this report and other handbook volumes to: AMRL/BBE, Wright-Patterson AFB, OH 45433; AUTOVON 78-53675 or 78-53664; Commercial (513) 255-3675 or (513) 255-3664.

Cole, John N., USAF Bioenvironmental Noise Data Handbook Volume 1: Organization, Content and Application, AMRL-TR-75-50 (1), Aerospace Medical Research Laboratory, Wright-Patterson Air Force Base, Ohio, 1975.

Cole, John N., USAF Bioenvironmental Noise Data Handbook, Volume 2: Procedure to Evaluate Effects of Non-standard Meteorological Conditions on Far-Field Noise, AMRL-TR-75-50 (2), AMRL, WPAFB, OH, 1975.

NEAR-FIELD NOISE

MEASUREMENTS

AMRL acquired near-field noise data on the T-37B aircraft during ground runup operations of its turbojet engines. For these tests the aircraft was located on a taxiway at Wright-Patterson AFB with no significant reflecting surfaces in the vicinity except the ground plane. Table 1 gives the surface meteorological conditions and the three engine/power conditions. The ground-crew chief selected power conditions and near-field locations generally used during routine maintenance or engine runup for preflight checks.

At each near-field location a test engineer randomly moved a hand held microphone in and around each location, probing all areas where a crew member's head would normally be located. He recorded all of the noise samples on magnetic tape. During analysis of each sample, he determined the root-mean-square sound pressure using a 4- or 8-second integration time to derive a power-averaged level for each location. Figure 1 shows the four near-field locations where ground crews are usually located for maintenance and/or preflight checkout operations. Estimates of noise levels at other locations in the near-field are difficult since the noise source is spatially distributed, i.e., not a point source. The noise levels at near-field locations can vary widely depending upon relative distances from each noise source (intake noise, exhaust noise, panel resonances, internal engine noise through the engine wall, etc.).

Table 1 lists the numeric/alphabetic designators used on the data pages in this report to identify the measurement locations and test conditions. For example, the designator 1/A means ground crew location 1 and test condition A.

RESULTS

The measured data presented in Table 2 define the sound pressure levels (SPL) produced by the T-37B aircraft at the four ground crew locations. This table includes the overall, 1/3 octave band, and octave band levels. From these data one can calculate the variety of measures given in Table 3, which are widely used to assess the effects of noise on personnel and their performance.

All near-field data are for the meteorological conditions at the time of test but are valid for all typical airbase meteorology because of the short sound propagation distances involved.

TABLE 1

MEASUREMENT LOCATIONS AND TEST CONDITIONS FOR NEAR-FIELD NOISE MEASUREMENTS

T-37B Aircraft, Ground Runup, Wright-Patterson AFB, OH 23 August 1972 Tail #74670

Ground Crew Location

1	Engine #1 Start
2	Engine #2 Start
3	Wheel Chock Pull
4	Leak Check/Trim Operation
Aircraft Engine Operation	
A	Engine #1 Idle Power
В	Both Engines Idle Power
c	Both Engines Takeoff Rated-Thrust Power
Meteorology	
Temperature	25 C
Bar Pressure	.760 M Hg
Rel Humidity	84 %
Vind — Speed	3.6 M/Sec (7 kt)
- Direction	200 Deg

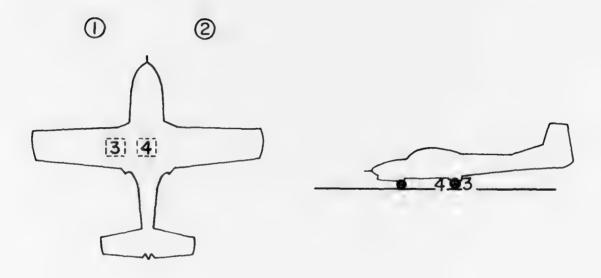


Figure 1. Near-Field Measurement Locations at Intersection of Taxiways 8 and 12, Wright-Patterson AFB, OH

FAR-FIELD NOISE

MEASUREMENTS

AMRL acquired both near and far-field data during a 1-2-hour test period, thus keeping similar meteorological conditions. Figure 2 shows the ground runup pad, ground cover, aircraft orientation and the 19 microphone measurement sites on a semicircle. The center of the 75 meter radius semicircle used in surveying the J69-T-25 engines was on the ground directly below the intersection of the aircraft's centerline and the plane passing through both engines' exhaust-nozzle exits.

Table 4 provides cockpit readouts of engine characteristics (% RPM, fuel flow, etc.) for each power setting used in the far-field tests. Also listed in this table are the surface meteorological conditions during data acquisition.

All microphone measurement sites are in the acoustic far-field of their source where the sound wave-fronts spherically diverge and the noise source may be regarded as a point source.

A portable microphone/tape-recorder system was used to sequentially record the noise at each far-field location. The microphone was attached to a hand held pole, pointed at the source (0° angle of incidence) and vertically scanned from 0.5 to 3 meters for a period of 5-10 seconds during data acquisition at each microphone location. These samples were then time-integrated to derive a root-mean-square sound pressure level. Vertical scanning and time-integrating together reduce anomalies frequently present in data acquired by a fixed height microphone.

RESULTS

Table 5 lists the overall and 1/3 octave band SPL measured at the far-field locations under meteorological conditions at the time of the test. Data in all other figures and tables are based on these levels. These data were normalized to 100 meters distance and standard meteorological conditions (15°C temperature, 70% relative humidity, 0.760 meter Hg barometric pressure) and used to derive the graphic data in Figure 3 which provides a compact summary of the far-field noise characteristics of the T-37B aircraft in a standard format.

Figure 4 and Table 6 present two basic acoustic measures, the acoustic power level and the directivity index, respectively. The acoustic power level describes the power radiated by the source as a function of frequency. The directivity index is a standard acoustical engineering measure that describes the geometric way in which the source radiates this power as a function of both frequency and angle from source. These basic source measures are primarily of interest for acoustical engineers and noise generation/control specialists.

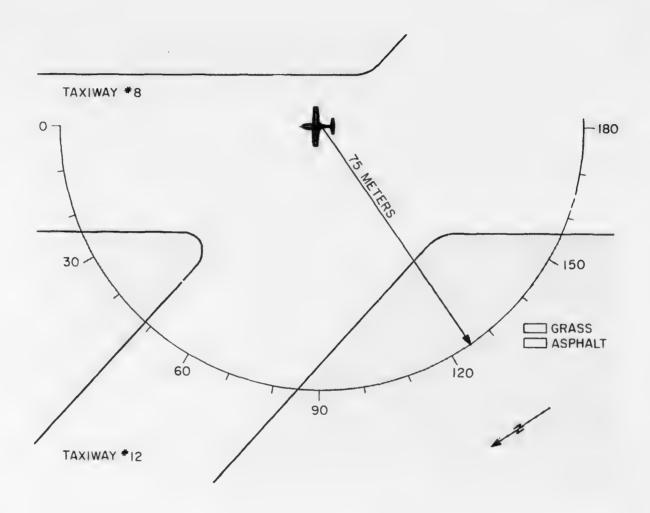


Figure 2. Far-Field Measurement Locations at Intersection of Taxiways 8 and 12, Wright-Patterson AFB, OH

Figures 5 through 11 are sets of equal noise contours describing seven different measures of noise as a function of angle and distance from the source for standard day meteorology. They are respectively, overall sound pressure level, C-weighted sound level, A-weighted sound level, perceived noise level, speech interference level, permissible exposure times for personnel and octave band sound pressure levels.

Data excessively influenced by spurious background/electronic noise were eliminated from all figures and tables. No data are presented at the 180 degree locations for the trim-check power setting because of turbulent air flow behind the aircraft.

Test personnel performed noise surveys during quiet periods when the background noise was minimal, e.g., early in the morning when no other aircraft or engine test stands were operating. Data eliminated because they were near the background/electronic noise were generally not significant because the levels were so low (e.g., Table 5 and Figure 11 at idle power).

Volume 2 of the handbook describes the influence of meteorology on far-field noise environments, and provides, if required, the factors necessary to adjust the handbook's standard meteorological day data.

2 1/3 OCTAVE							3.2
NOISE SOURCE/SUBJECT:	0	OFERATION	. NO				2
T-37B AIRCRAFT	٠) 04 DEC 74
GROUND CREW NEAR FIELD NOISE LEVELS) PAGE F1
# = = = = = = = = = = = = = = = = = = =					OCATION	LOCATION/CONDITION	
FREQ (HZ)	1/4	278	3/3	4/B	3/4		
er.	7.3	73	00	8.9	93		
31.5	73	8 3	85	8 9	96		
0 3	15	86	6.9	95	101		
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125	37	8 9	Ü	0	106		
160	83	83	100	101	106		
200	83	. † .	36	26	109		
20.00	N 0	# C	0 0 0	9 0	113		
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200	000	0 0	מ מ	96	113		
0.89	93	93	9.6	96	112		
800	95	93	0	66	115		
1000	93	96	0	0	115		
1250	96	9	0	0	116		
1600	100	0	0	104	116		
0002	171	V 4	N 4	V .	116		
24E0	111		- 9	⊣ 0	1110		
2120	* 4 D 4	-	7	ט ע	1 + 1		
2000	103	106	105	100	117		
6300	104	0	0	0	114		
8000	101	0	\rightarrow	9	113		
10000	100	0	0	16	117		
NA PARA	000	200	100	4.00	127		

TABLE: MEASURED SOUND PRESSURE LEVEL (D3) 2	RESSUR	ELEVEL	(03)) IDENTIFICATION:) OMEGA 3.2
NOISE SOURCE/SUBJECT:		OPERATIONS	. NO		6 4 5 6 8 6 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8	
T-37B AIRCRAFT GROUND CREW NEAR FIELD NOISE LEVELS) 04 NEC 74) PAGE J1
**************************************					LOCATION/CONDITION	. 5 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6
F4EQ (H2)	1/4	278	3/3	4/8	2/4	
31.5	78	60	92	36	102	
63	36	87	100	102	109	
125	39	69	103	107	110	
250	37	80 80	101	101	116	
200	66	96	103	101	117	
1000	66	101	101	105	120	
2000	122	124	123	125	121	
4000	113	115	112	105	126	
8000	107	111	108	102	119	
OVERALL	122	125	124	126	127	

TABLE: MEASURES OF HUMAN NOISE	NOISE	EXPOSURE	URE			IC	IDENTIFICATIONS
~							OMEGA 3.2
NOISE SOURCE/SUBJECT:	0	OPERATIONS	8 NO		~ *		RUN 01
T-378 AIRCRAFT							04 DEC 74
GROUND CREW NEAR FIELD NOISE LEVELS			i		•		PAGE H1
					LOCATION/CONDITION		
	1/A	2/8	3/8	4/8	0/4		
HAZARD/PROTECTION C-WEIGHTED OVERALL SOUND	IND LEVEL		SLC IP	1 080	ΔT		
υ, m	195		(OASLA IN MINUTES) F	FOR ONE	T EAR EXPOSURE PER	DAY (AFR 161-35, JULY 73)	3
OASLC	122	124	124	125	127		
DASLA	123	126	125	127	127		
MINIMUM GPL EAR MUFFS		L	L	L.	ì.		
DASLA	46	96	96	97	101		
AMEDICAN COTTCAL 1700 SAD		09	09	20	25		
3		6	00	4	96		
	240	170	170	143	09		
V-51R EAR PLUGS							
OASLA*	91	93	93	76	66		
		974		82	36		
AMERICAN OPTICAL 1700 EAR				EAR	PLUGS		
DASLA	960	960	960	0 90	36		
H-133 GROUND COMMUNICATION UNIT	ON UNI						
UASLA®	95		46	98	66		
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	1	÷ +	4	7	7		

* BASED ON CALCULATED SPL SPECTRUM UNDER PROTECTIVE DEVICE. P ADDITIONAL EAR PROTECTION REQUIRED.

TABLE 4

TEST CONDITIONS FOR FAR-FIELD NOISE MEASUREMENTS

T-37B Aircraft, Ground Runups, Wright-Patterson AFB, OH 23 August 1972 Tail #74670

Aircraft Engine Operation

Idle Both Engines

37 % RPM NC (Core Speed)

565 C EGT (Exhaust Gas Temperature)

300 LBS/HR FF (Fuel Flow)

Trim Check Power Both Engines

92 % RPM NC 560 C EGT 800 LBS/HR FF

Military Power 99.5 % RPM NC

645 C EGT 1050 LBS/HR FF

Meteorology

 $\begin{array}{cccc} \text{Temperature} & 25 \text{ C} \\ \text{Bar Pressure} & 0.760 \text{ M Hg} \\ \text{Rel Humidity} & 84 \% \\ \text{Wind} & \text{Calm} \\ \end{array}$

	1/3 OCTAVE DISTANCE =		METERS	ERS													-		1.4
T-378 J69-T-2	ISE SOURCE/SUBJEC 1-37B AIRCRAFT J69-T-25 ENGINE FAR FIELD NOISE			00	RATI DLE 7% R OTH REE	H H H H	S	1 1 1	\$ \$ \$	20000	E LLE	TEOROLOGY TEMP BAR PRESS REL HUMID		8605 4 4 C	£		RUN 03 09 HAY	75-60 01 7 75 2	
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80	63		49	29	9	60	61	61	61	61	61	69	62	99	29	29	65	29	
100	63		62	59	61	63	63	49	69	63	19	29	65	69	20	69	99		
125	79		40	49	20	14	20	76	15	20	73	52	17	80	80	17	2	53	
160	65		49	9 9	9 (9 0	20	72	72	20	69	72	72	44	52	73	& I	57	
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400	19		99	49	62	29	99	6.6	68	69	49	63	63	65	61	62	61	8 4	
200	99		99	49	62	20	68	7.0	69	69	99	49	49	69	6.0	53	99	44	
630	69		69	99	65	69	68	68	68	69	69	49	65	49	53	22	99	43	
800	7.1		69	99	65	69	68	69	69	69	99	62	29	65	69	25	22	42	
1000	73		71	7.0	69	25	7.1	4.2	73	7.1	68	99	29	49	29	58	52	44	41
1250	92		73	73	73	74	73	47	73	20	68	99	99	49	29	60	52	94	44
1600	49		73	14	14	73	71	73	7.1	71	68	65	49	63	59	28	54	4	43
2000	103	44	95	95	93	95	6.9	95	85	90	82	81	52	82	11	12	7.7	49	63
2500	92	91	8	86	3 1	83	80	48	17	81	73	73	20	7.1	89	99	62	52	S.
3150	15	2	8	7.5	20	73	7.1	4.	29	99	4	62	61	09	21	20	3	4	3
0004	30	87	90	80	9	80	7.8	52	7.8	5	62	65	65	62	62	20	5	24	\$
2000	92	80	16	11	25	15	7.4	23	72	20	19	63	61	61	23	22	64	\$ 5	4
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OVERALL	104	102	96	96	76	93	90	93	88	91	84	48	83	85	3 6	83	7.8	14	72

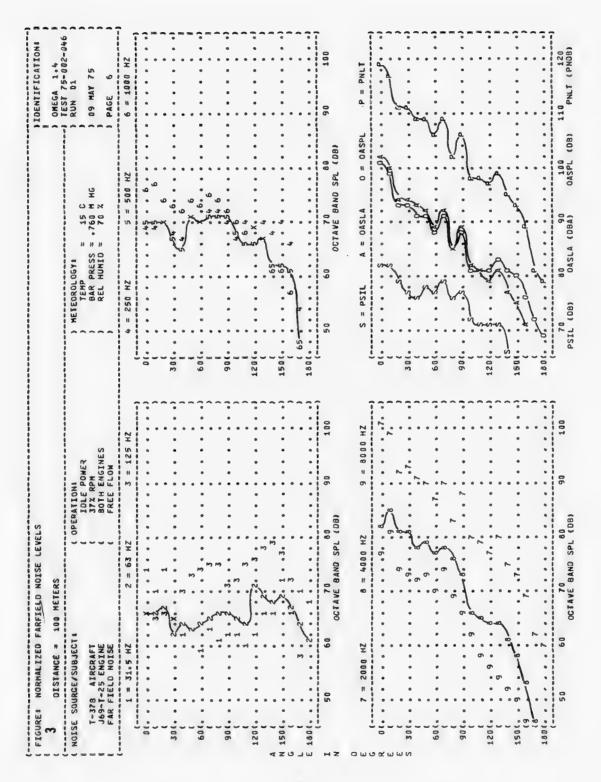
25	1/3 OCTA DISTANCE	CTAV	BAND 75	Z.													~~	er.	1.4	
NOISE SO	URCE/S	SOURCE/SUBJECT	1.1		OPE	ERATI	ONS	POWER		f 0 1	. A	METEOROLOGY TEMP	L0674				777	RUN	02	9
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AR B	-T-25 EN FIELD N	ENGINE NOI SE				BOTH ENGFREE FLO	FLOW	S				REL	GINO	40			~ ~	PAGE	~	
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(HZ)		0	10	20	30	04	20	60	2.0	80	06	100	110	120	130	140	150	160	170	180
25		7.8	19	68	99	99	69	69		65	99	75	99	68	69	7.1	72	20	68	
31.5	S)	78	99	99	68	99	68	69	99	68	29	73	68	7.0	72	73	92	14	7.1	
0 7		15	69	99	29	29	29	0.2	68	69	69	72	7.0	12	75	92	52	22	72	
200		72	99	90	9 0	9 6	9 6	70	0 2	17	72	73	72	5 6	22	0 0	60 c	6.	72	
2		1 0	9 4	6 9	2 5	. *	7.4	74	77	1 1	12	77	10	- «	U 4	9 4	* 0	. e	4 K	
100		7.1	7.7	71	72	73	7.	26	26	8	77	11	79	9 0	87	0 0	9 6	9 60	80	
125		72	72	73	73	73	25	92	26	79	80	80	80	65	80	91	06	19	69	
160		72	42	42	42	4.2	78	4	19	8.0	80	82	83	86	90	46	92	90	69	
200		14	14	92	15	25	78	62	80	82	82	83	49	67	06	95	93	80	69	
250		19	90	4	7.8	18	9.4	48	\$ 80	96	88	85	85	83	95	26	95	81	7.0	
315		80	62	80	4	11	48	85	84	86	88	82	85	3	87	93	95	80	69	
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200		78	29	80	11	26	\$	82	82	96	89	86	9 6	87	8	89	86	12	29	
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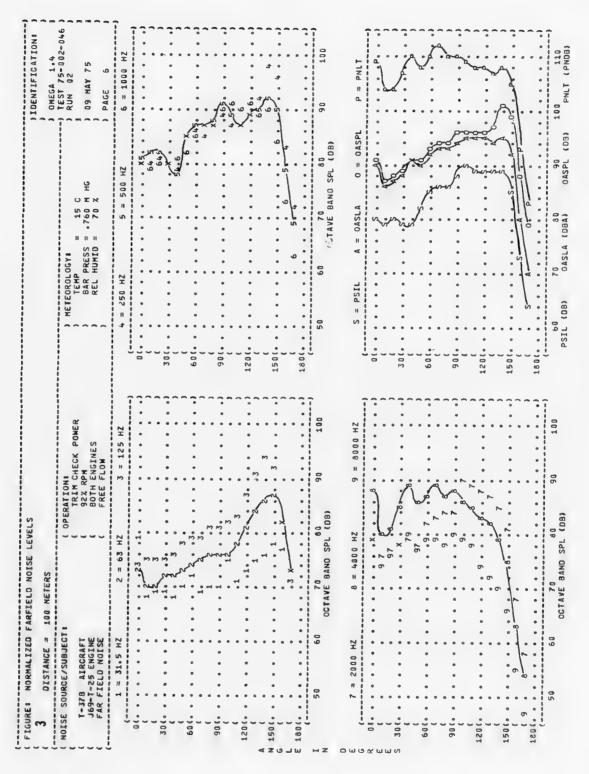
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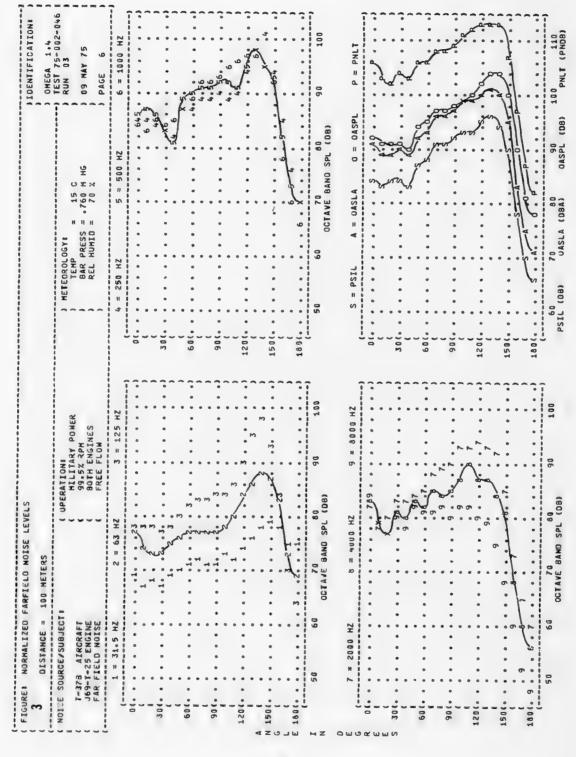
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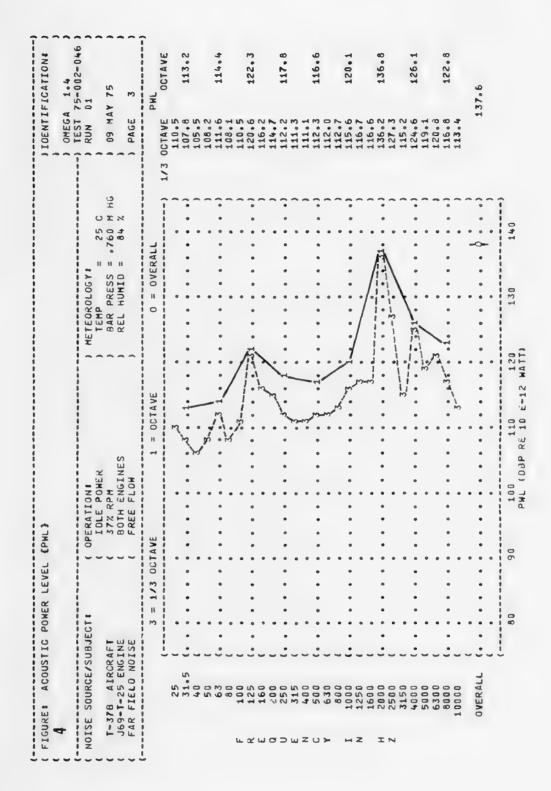
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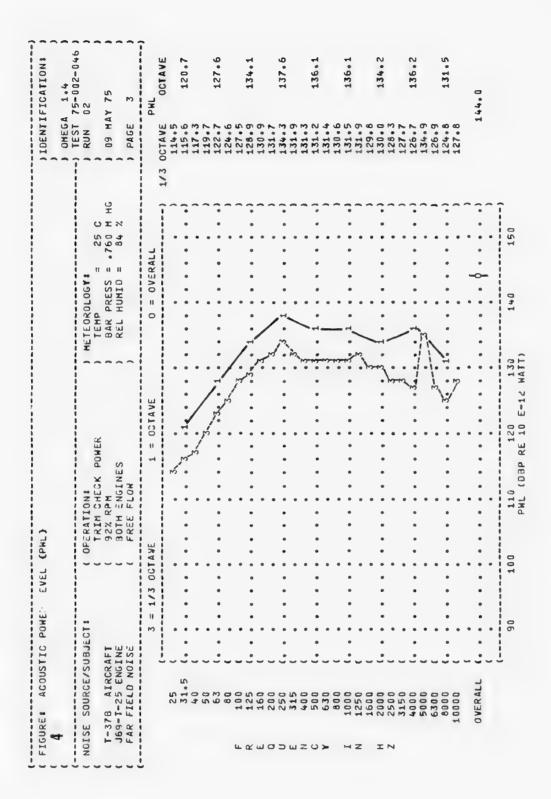
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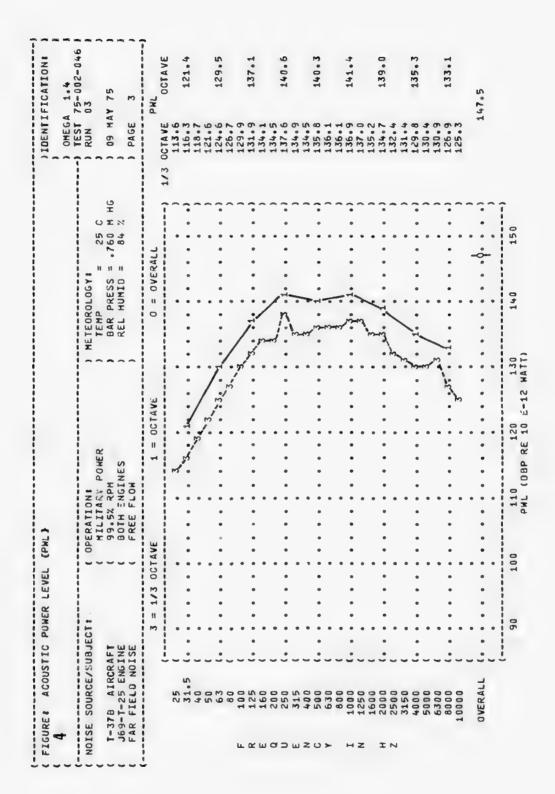


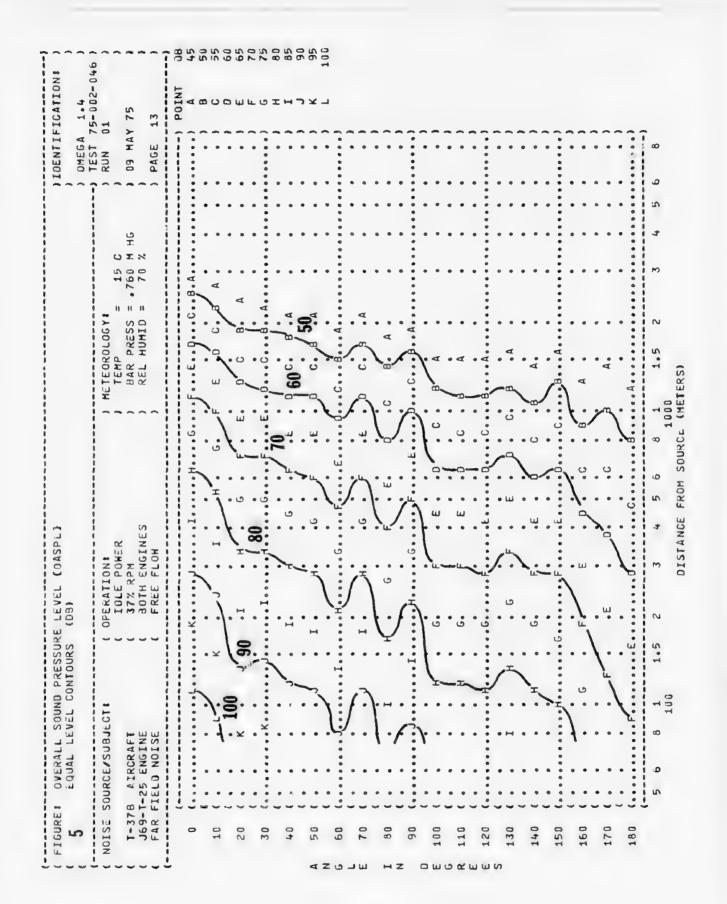


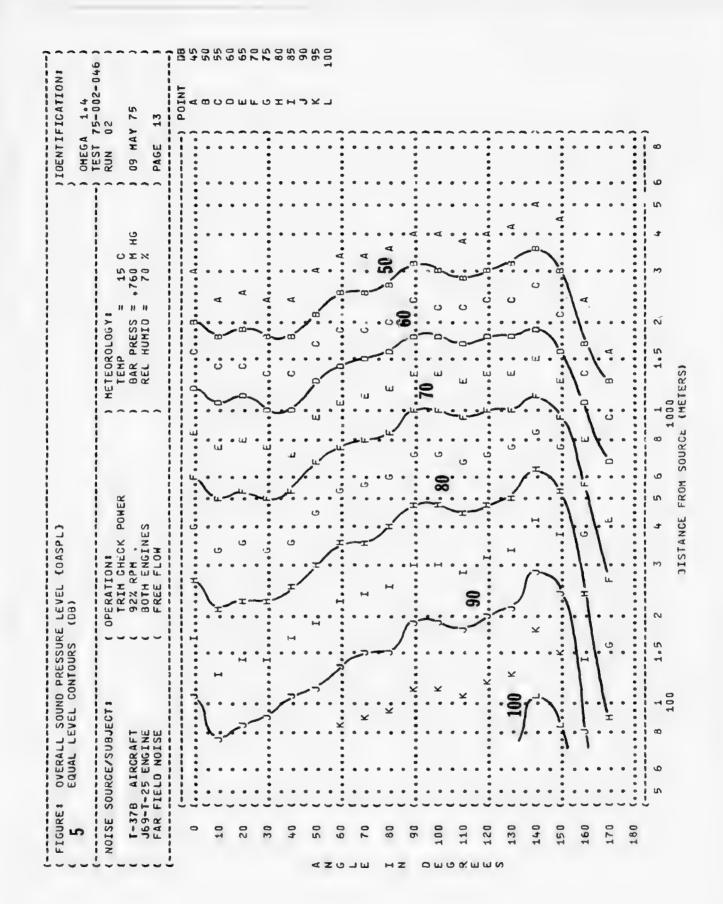


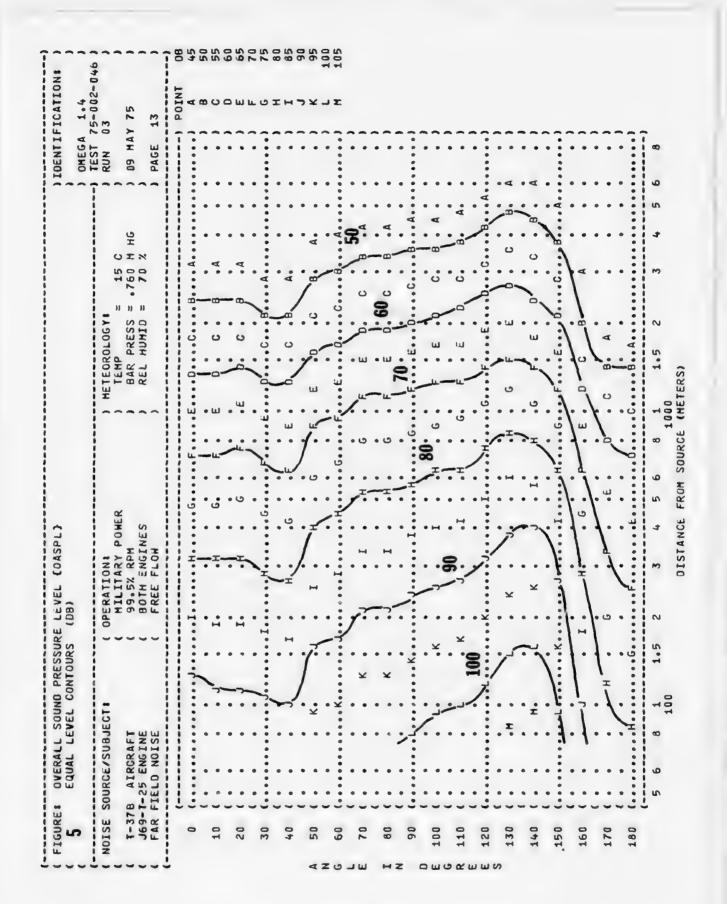


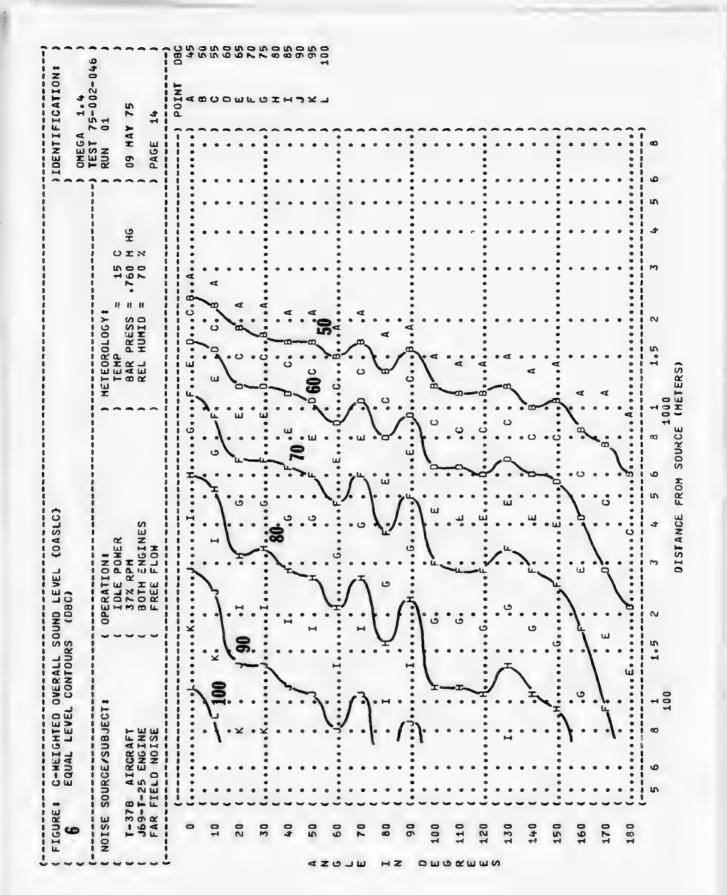


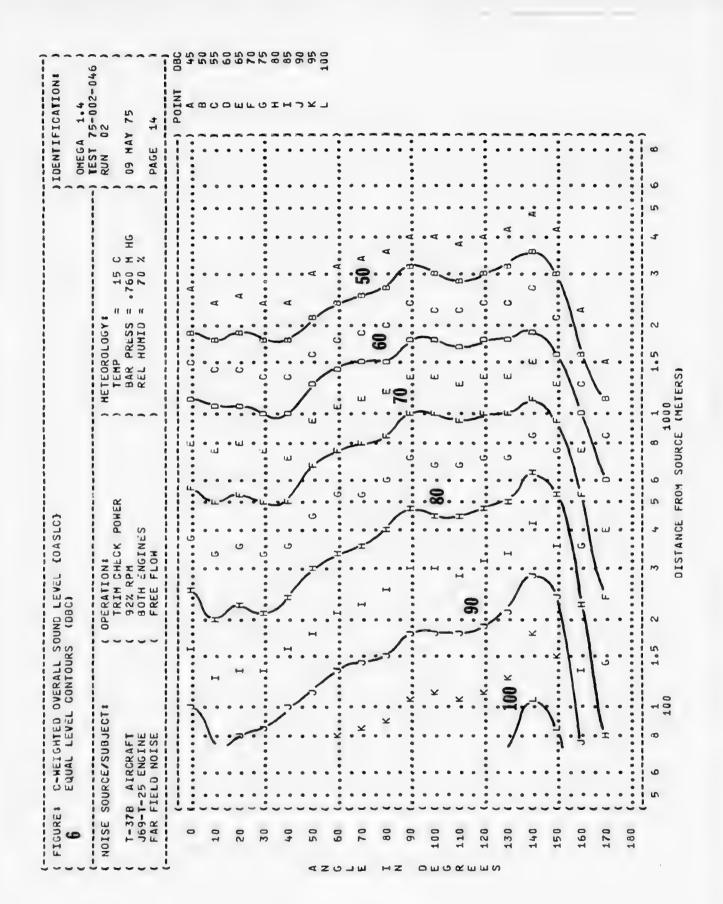


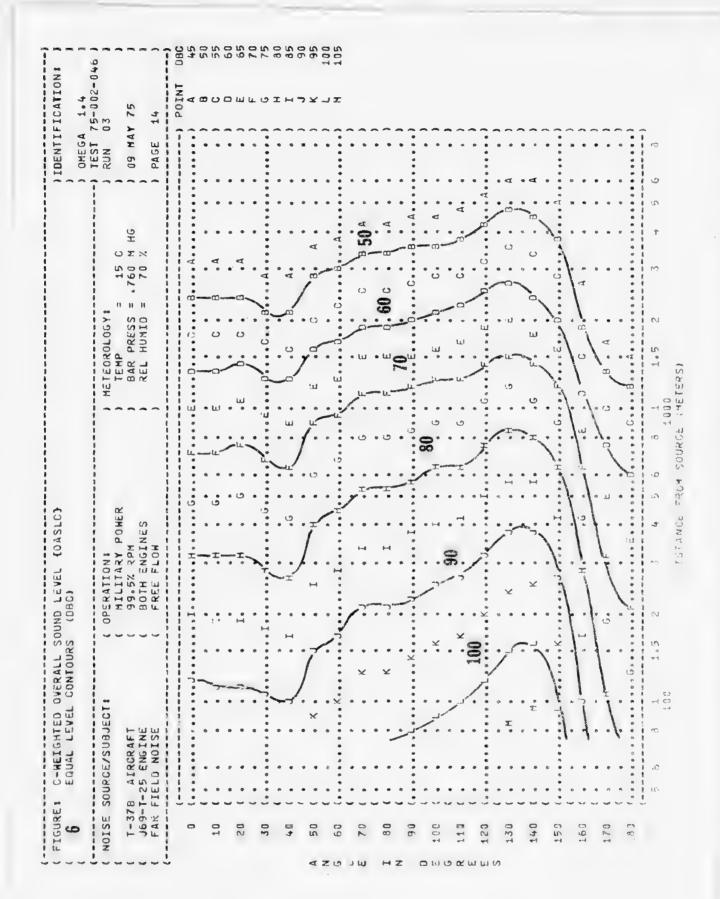


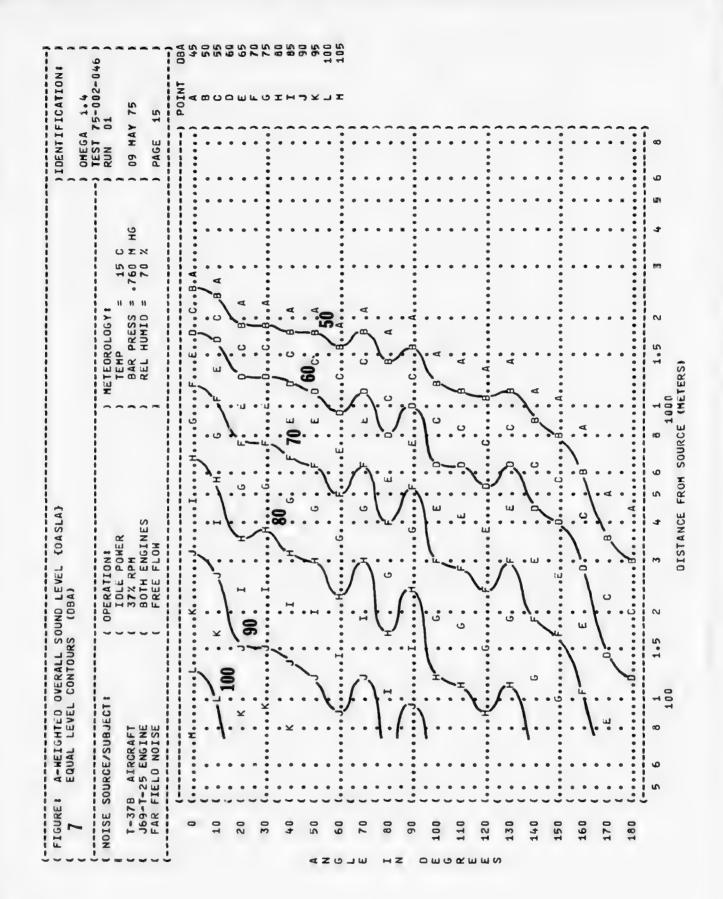


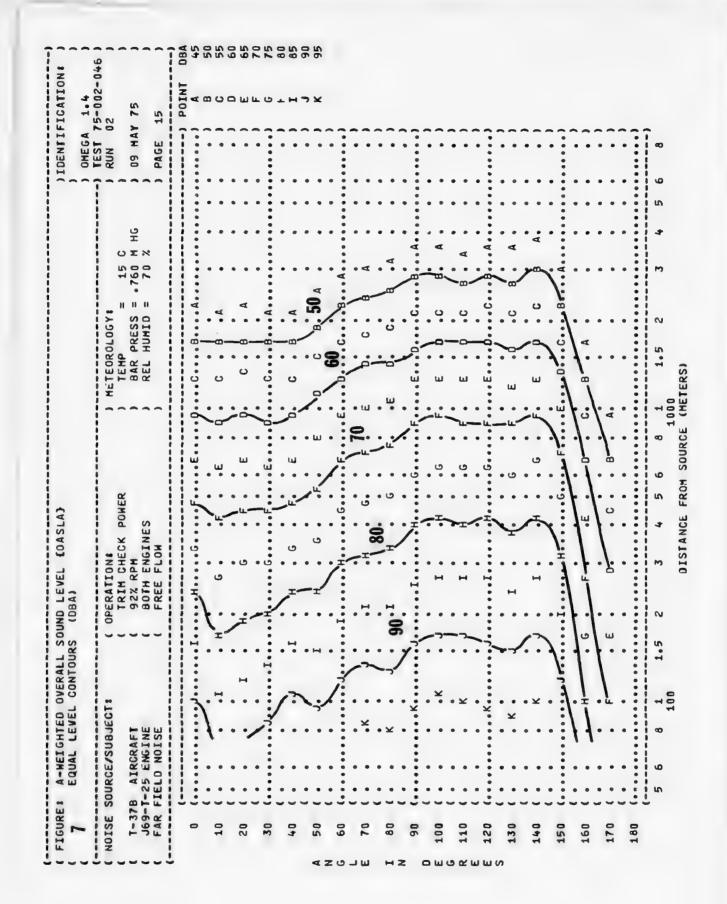


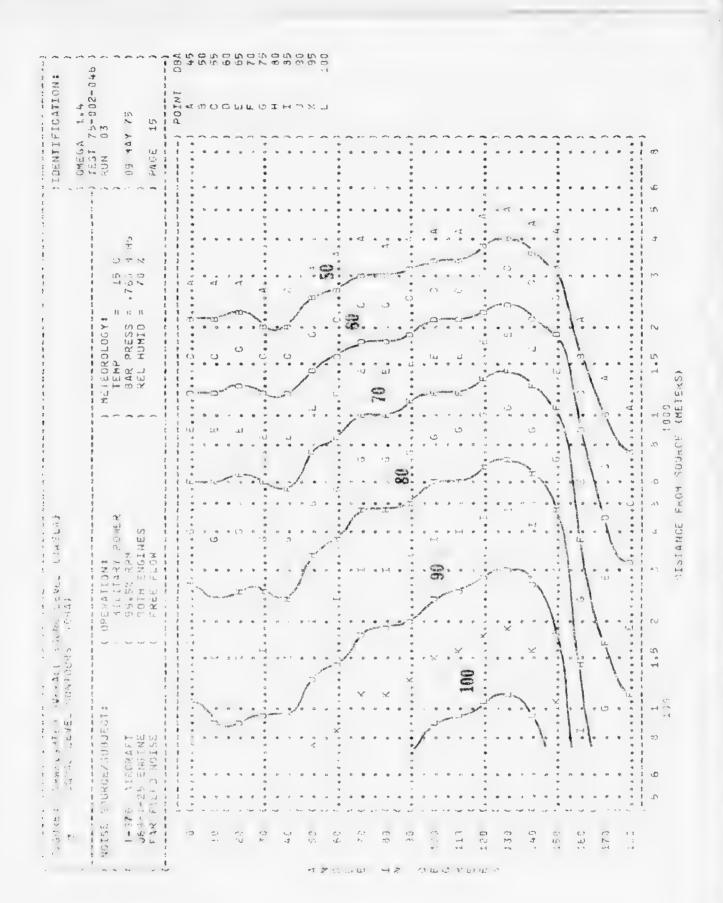


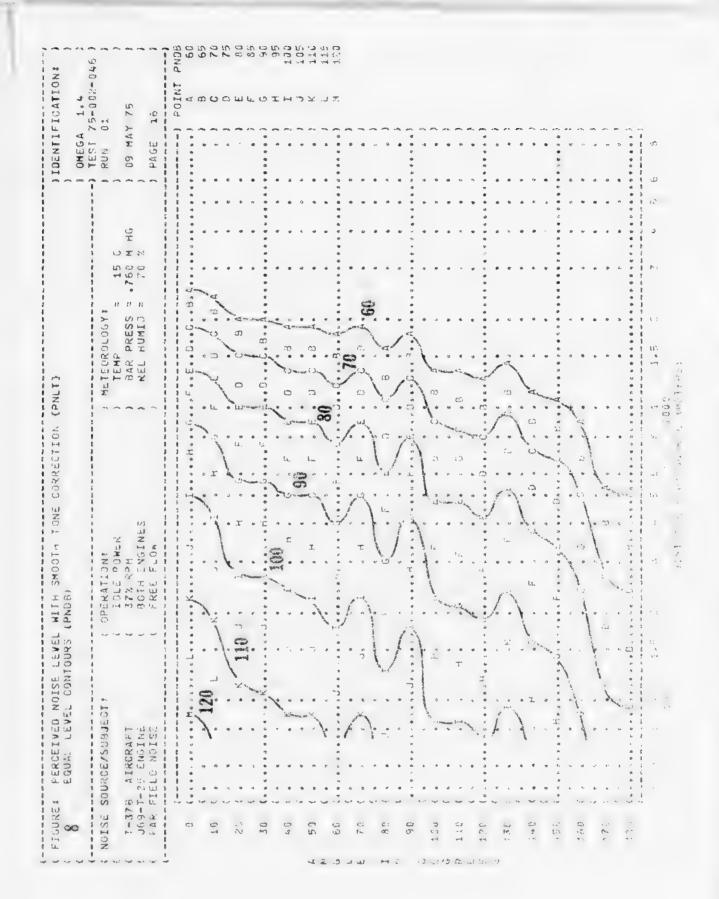


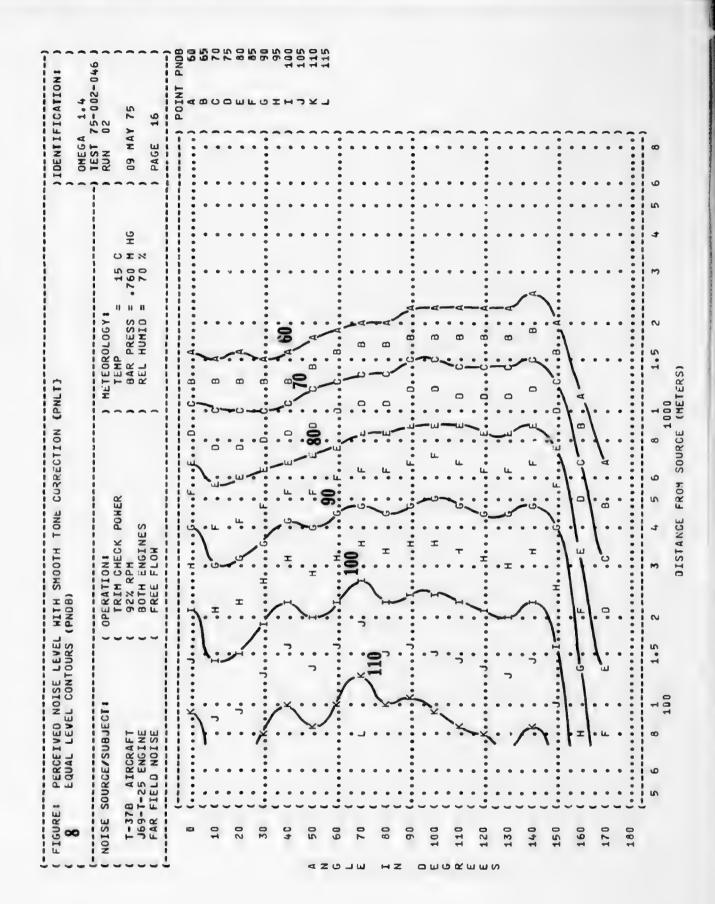


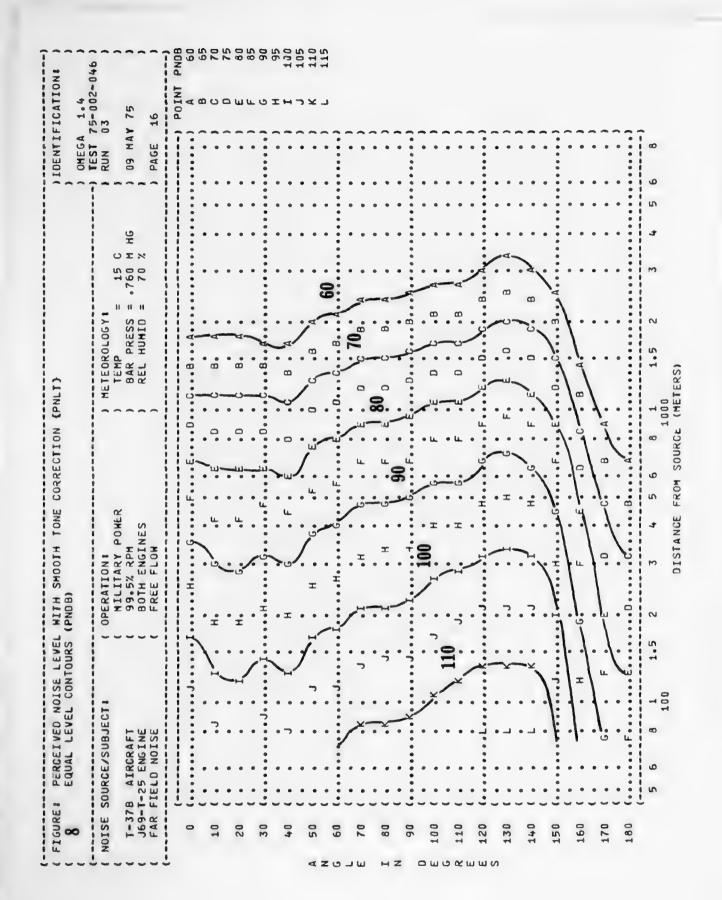


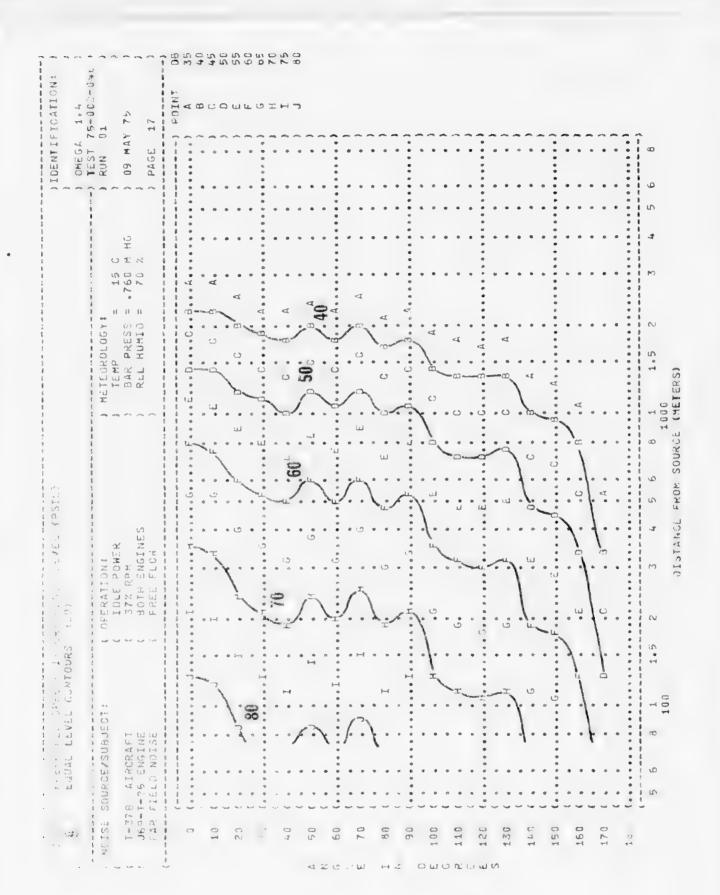


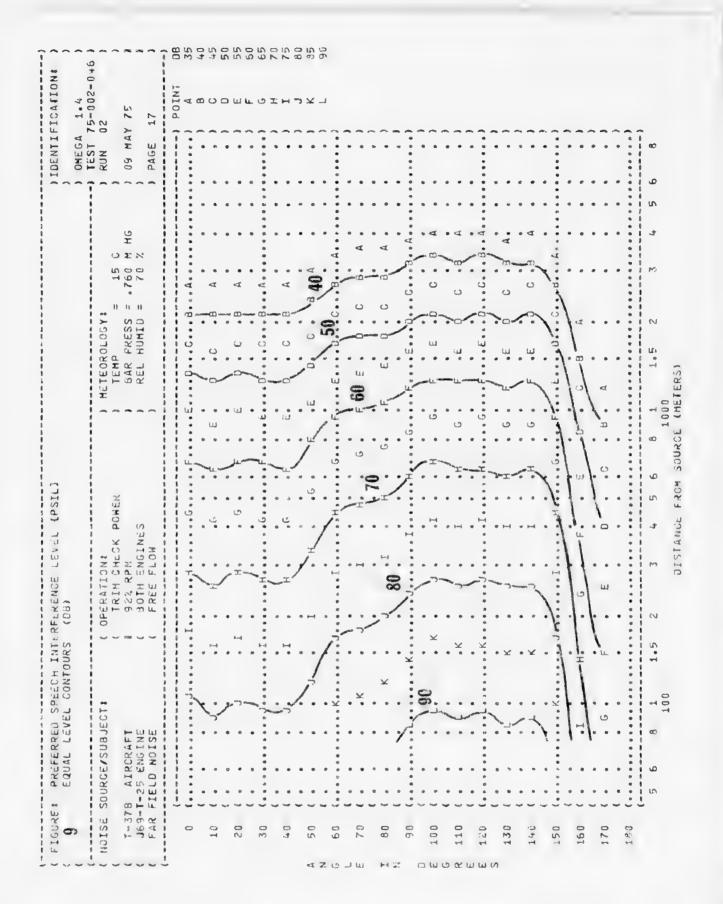


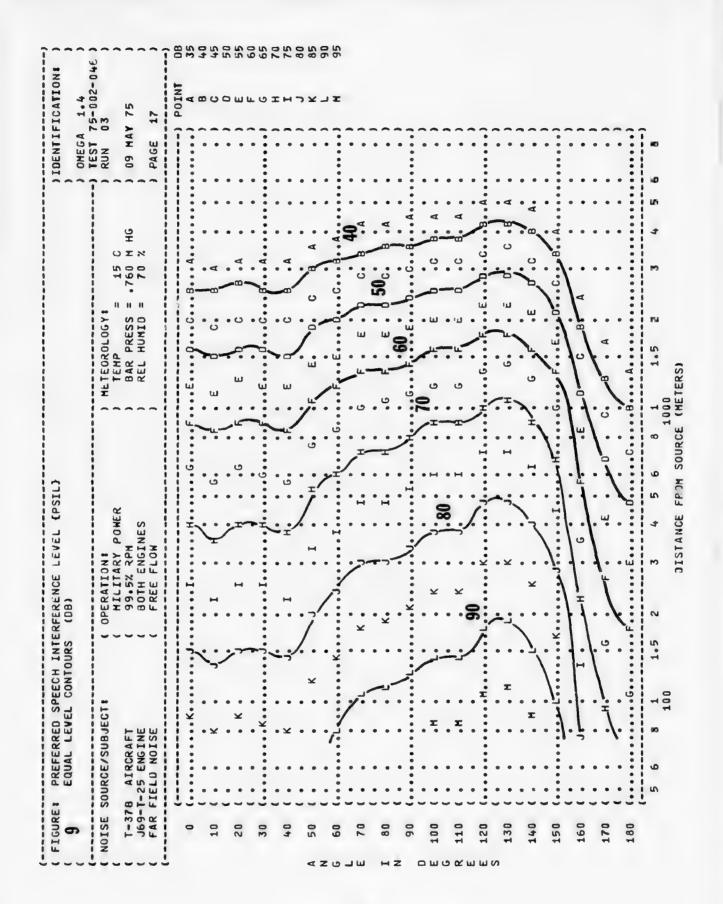












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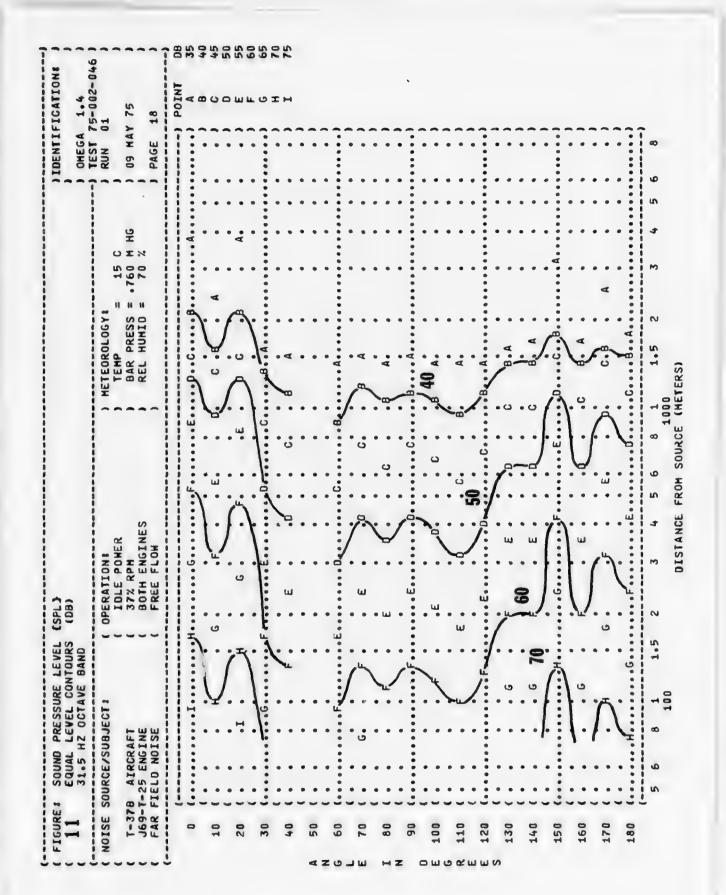
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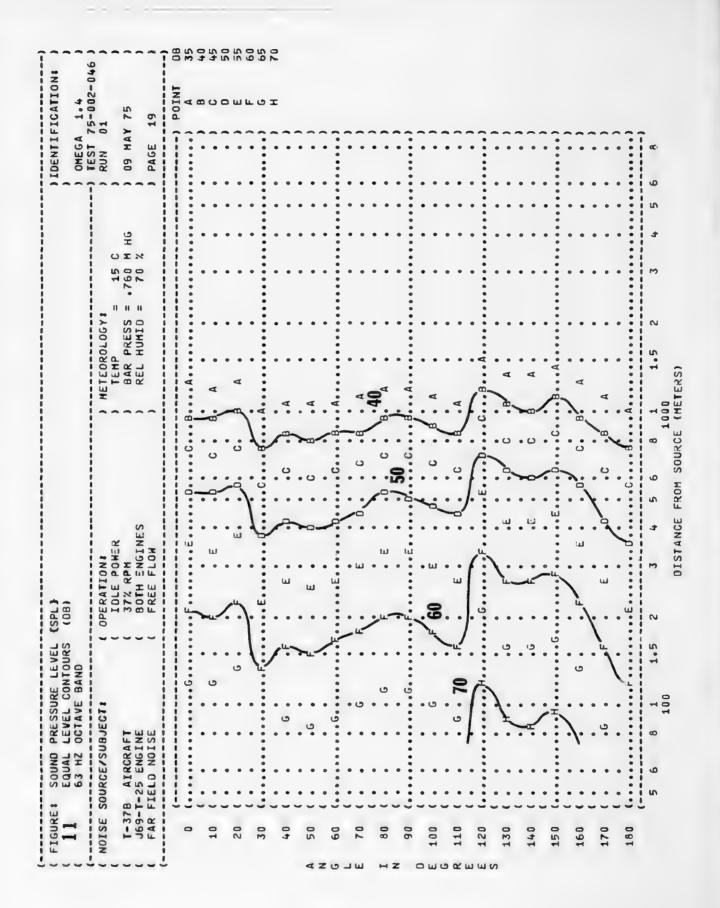
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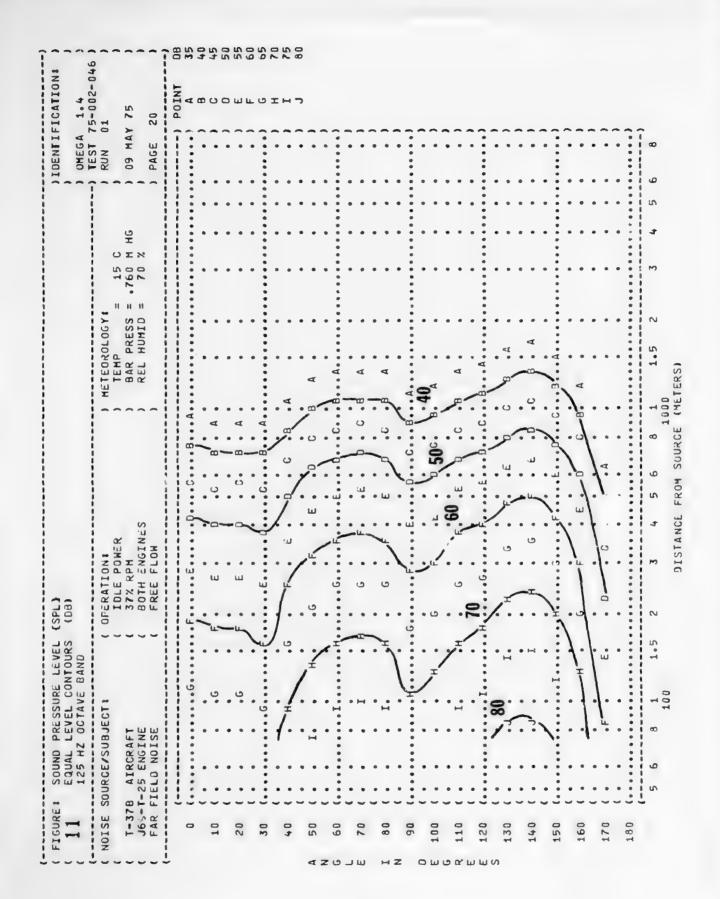
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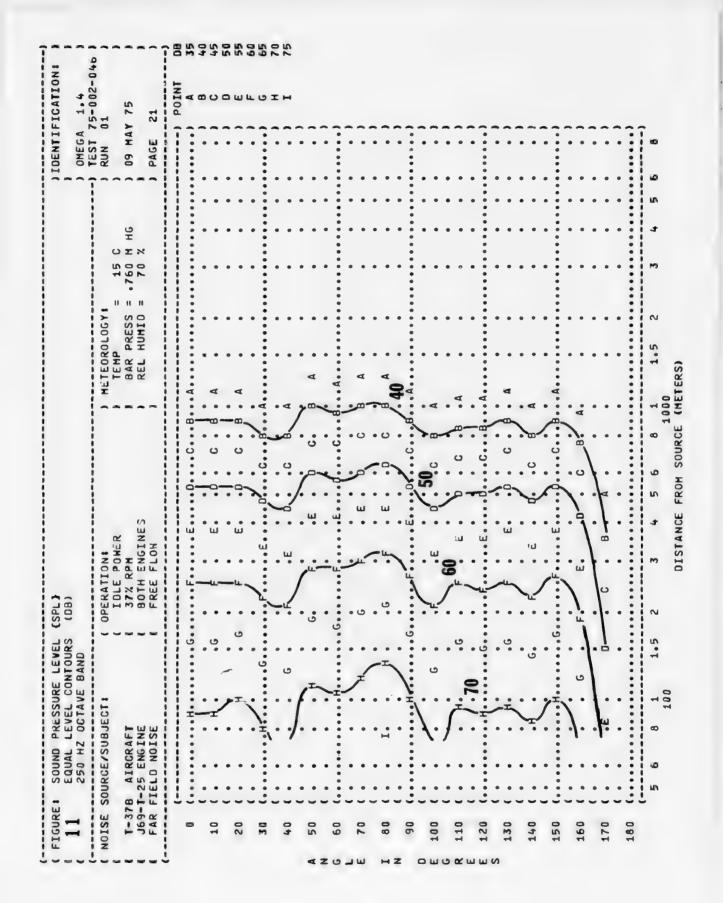
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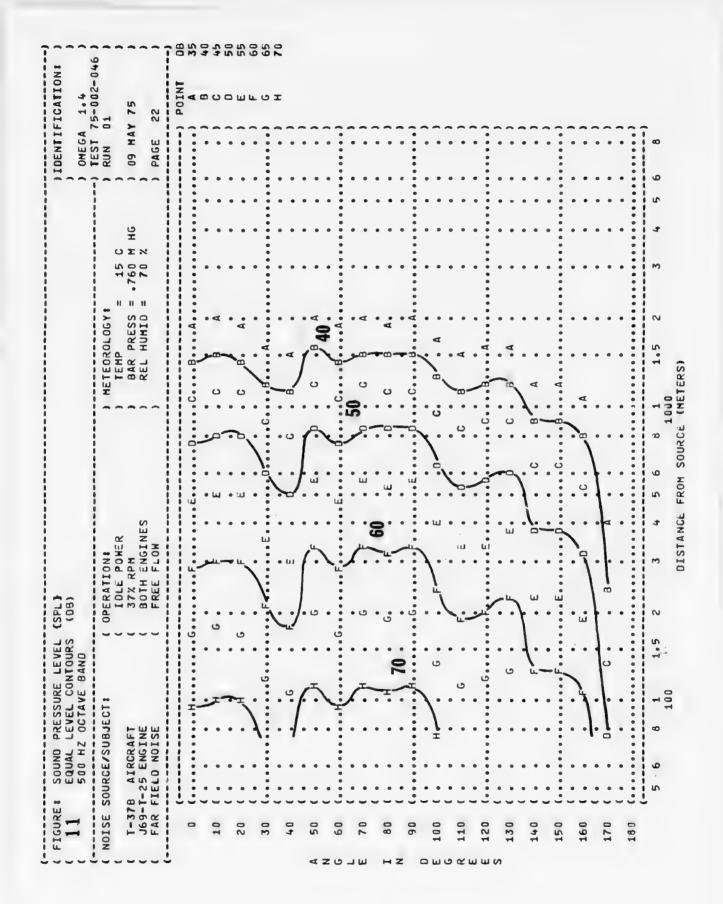
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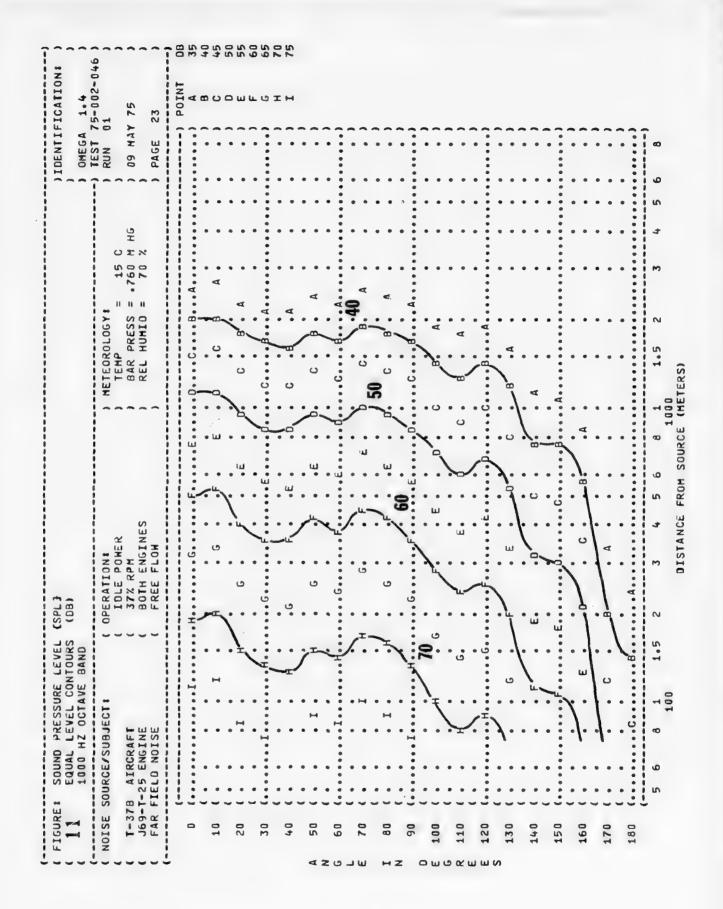


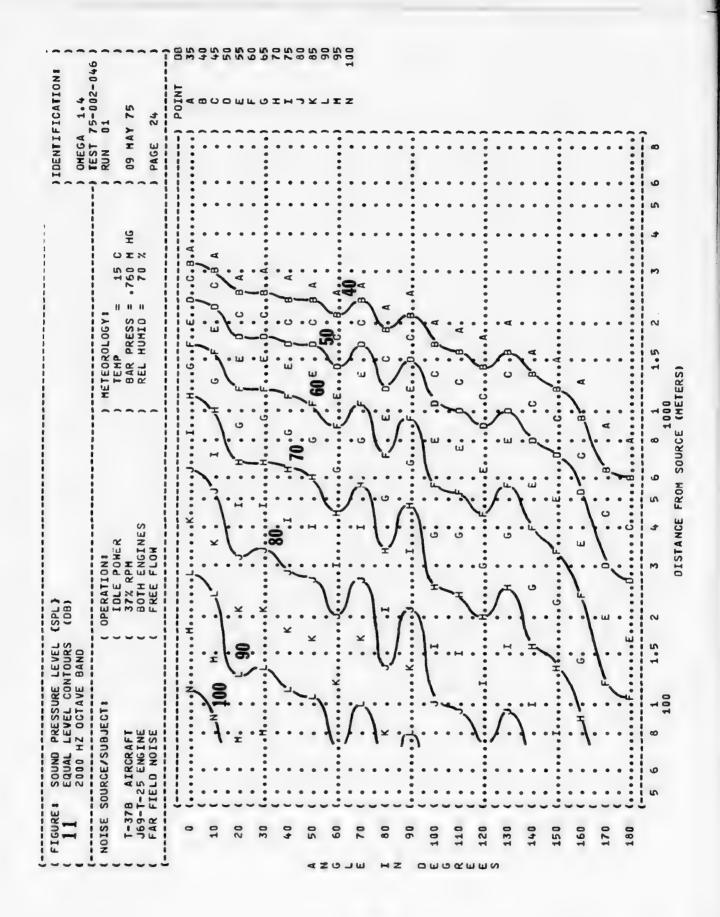


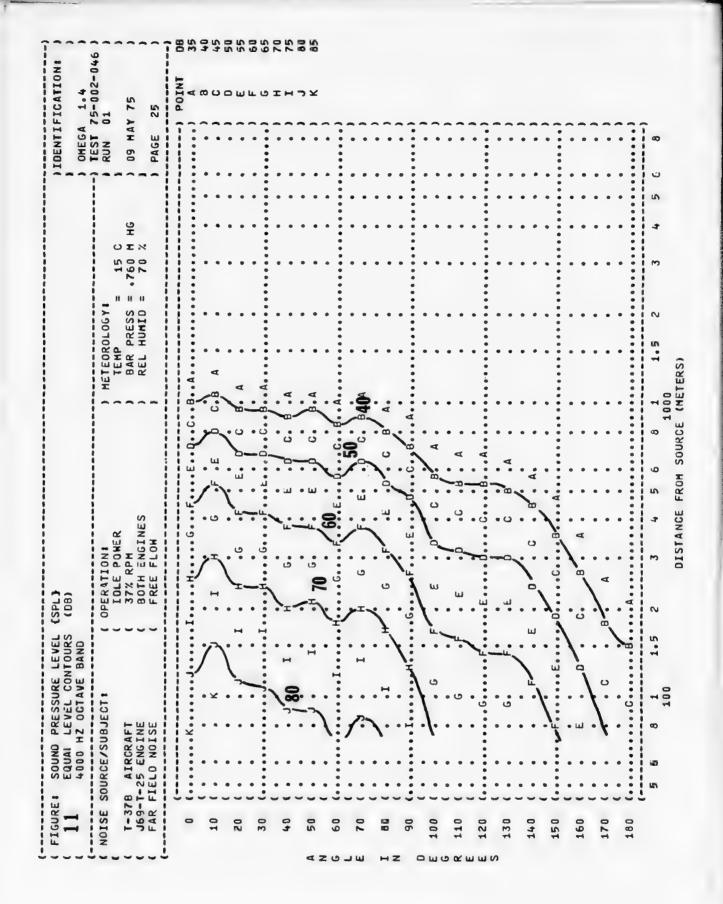


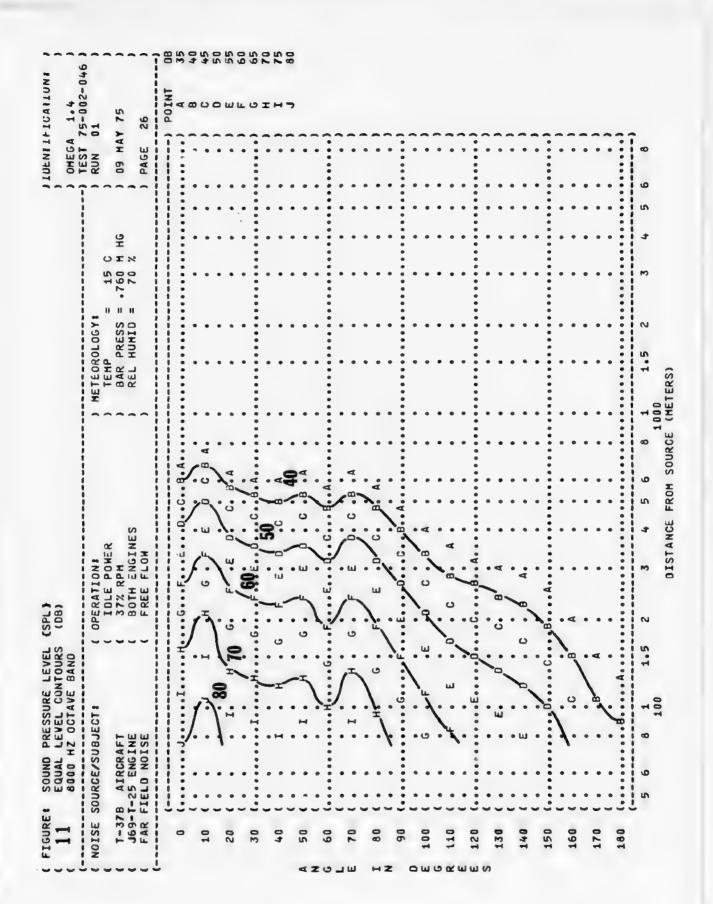


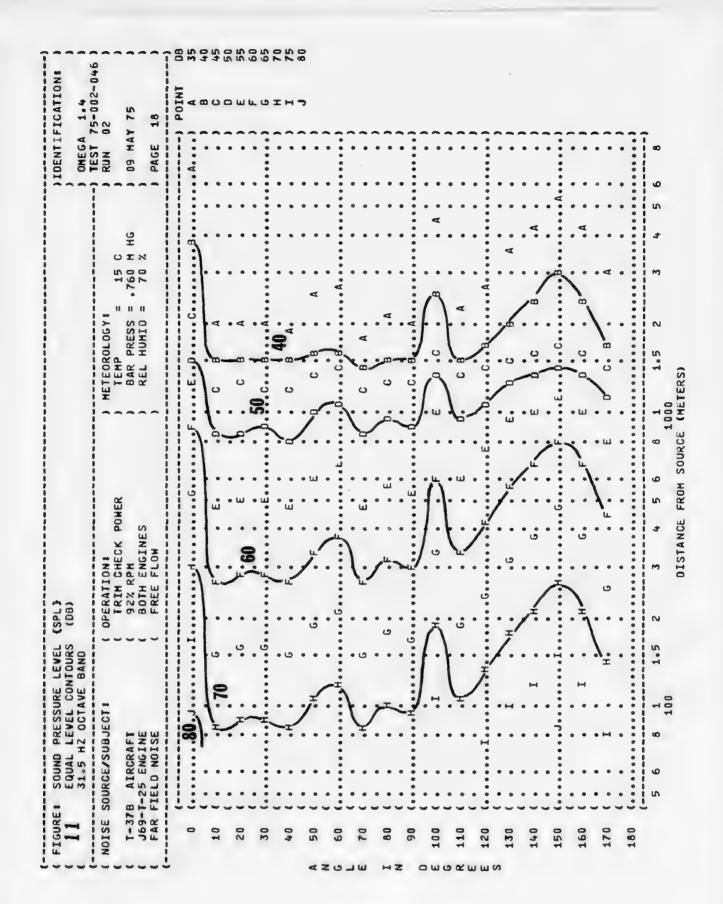


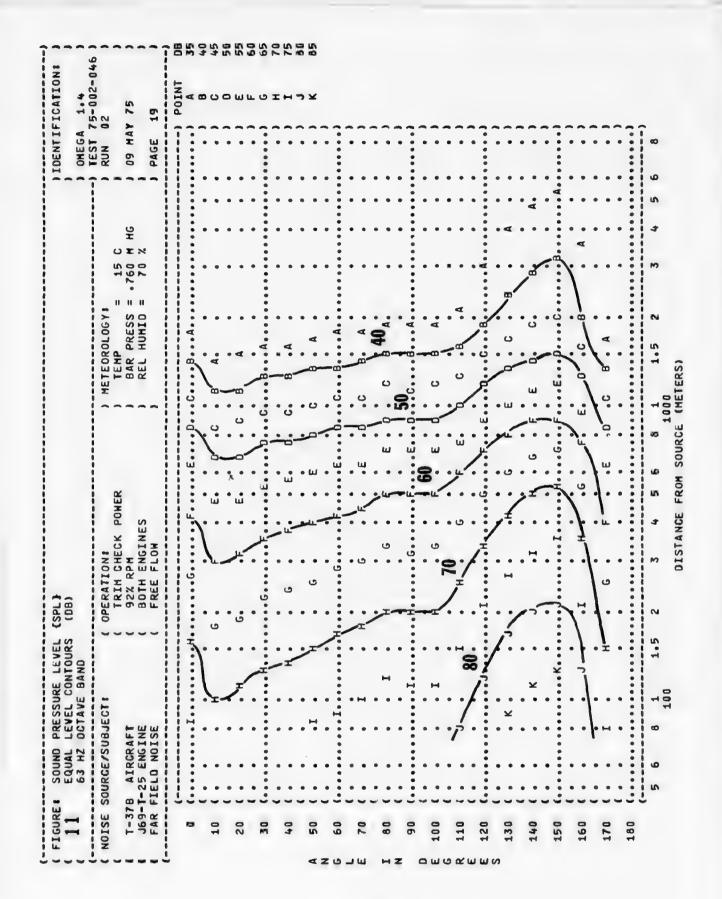


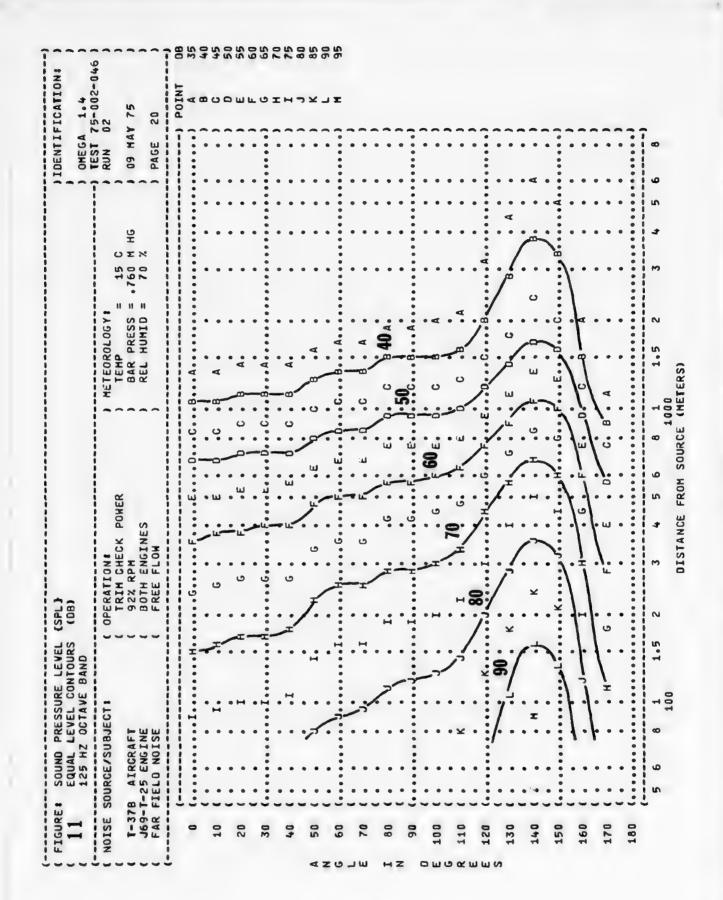


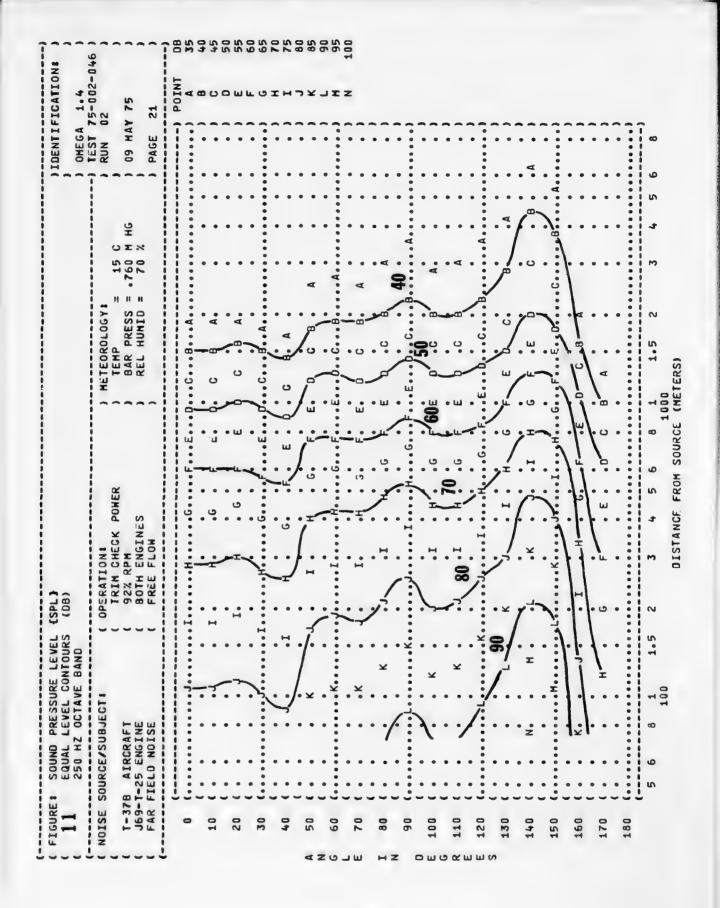


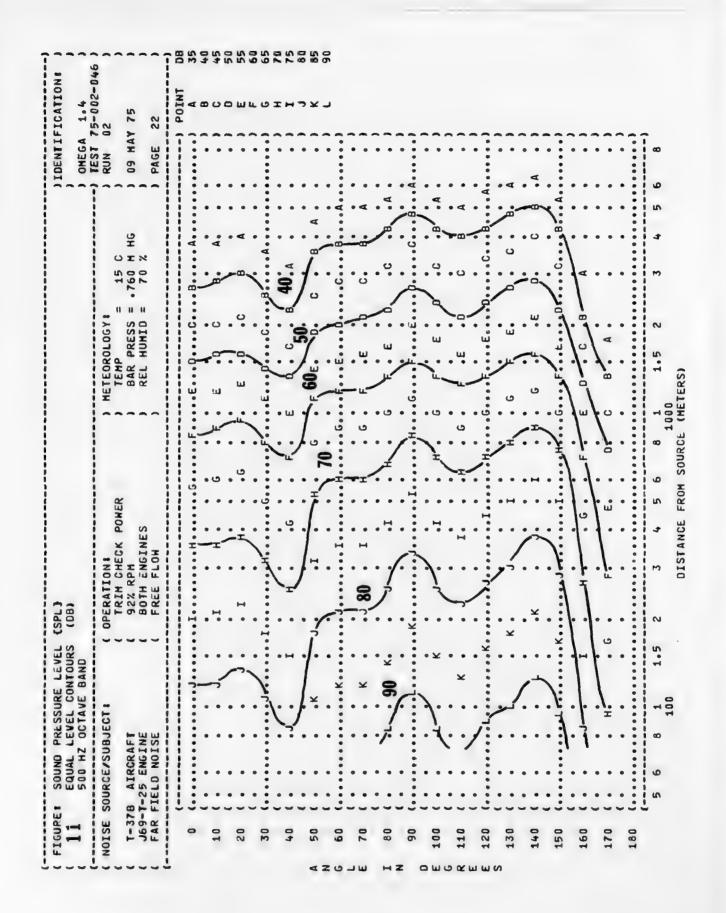


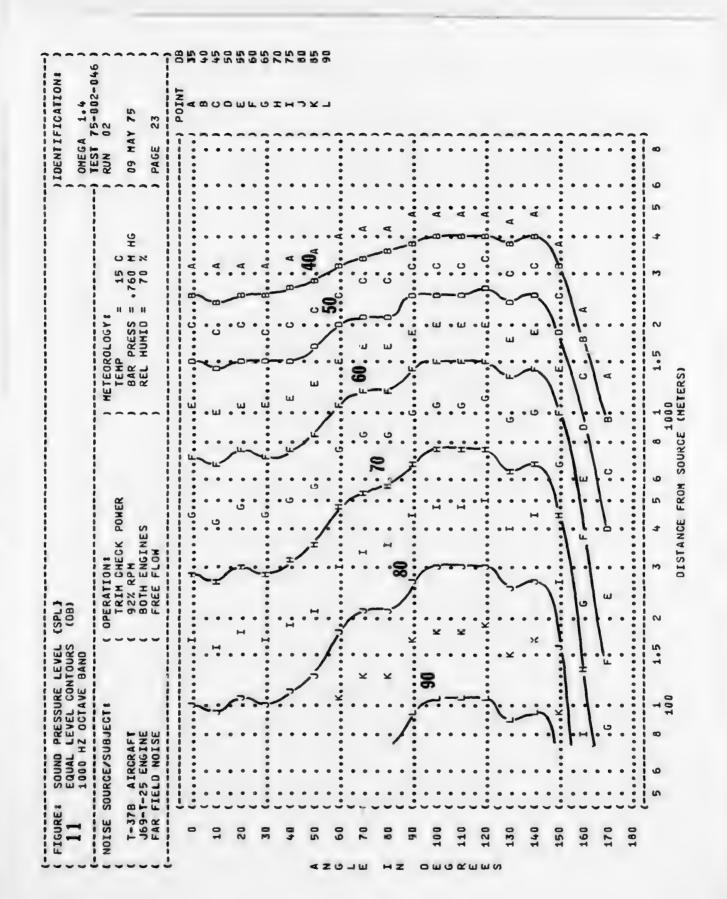


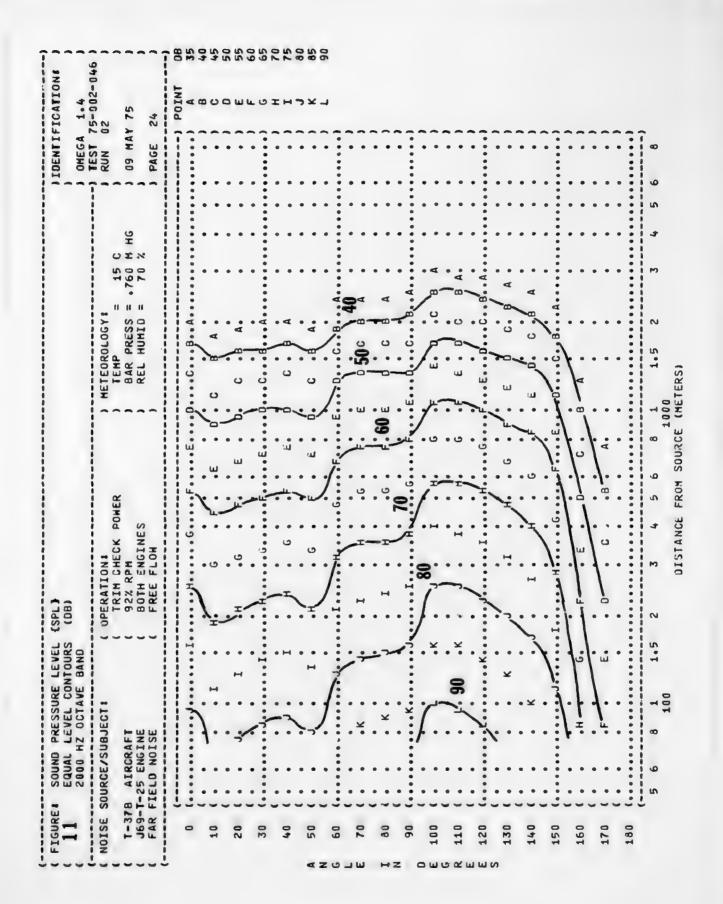


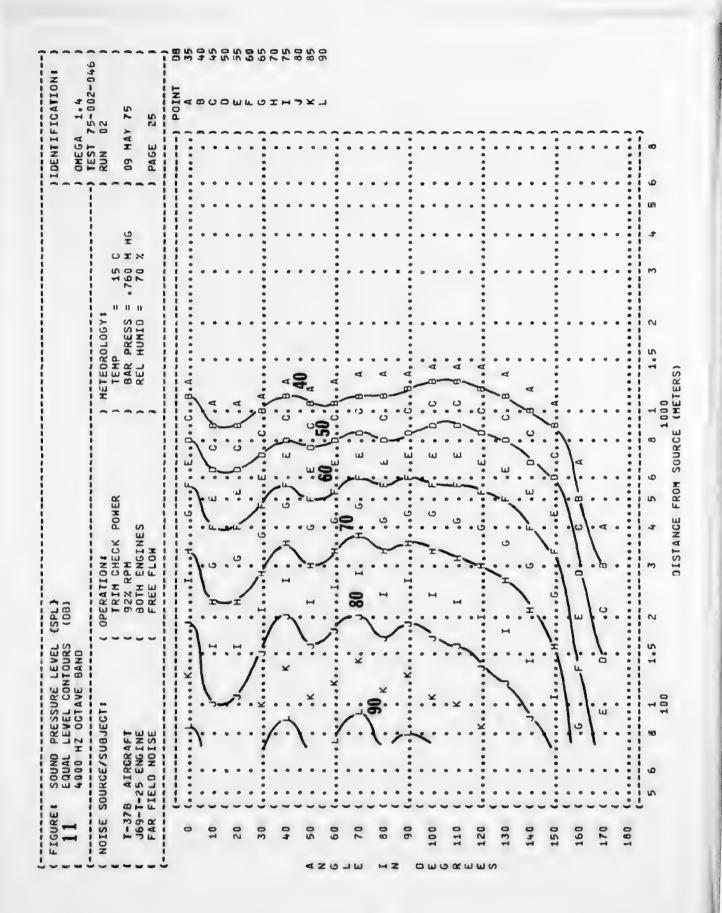






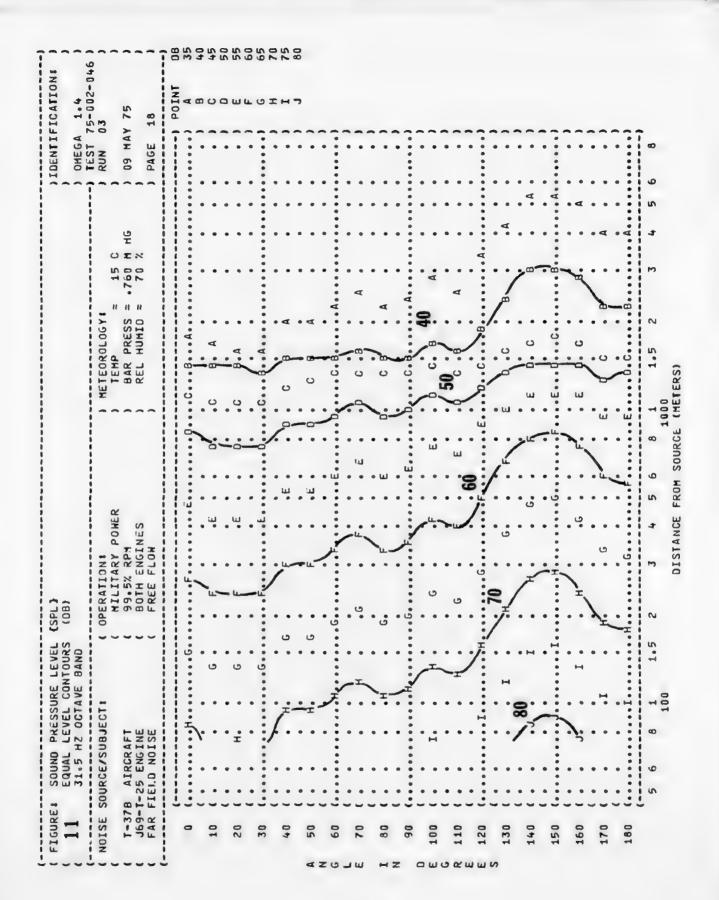


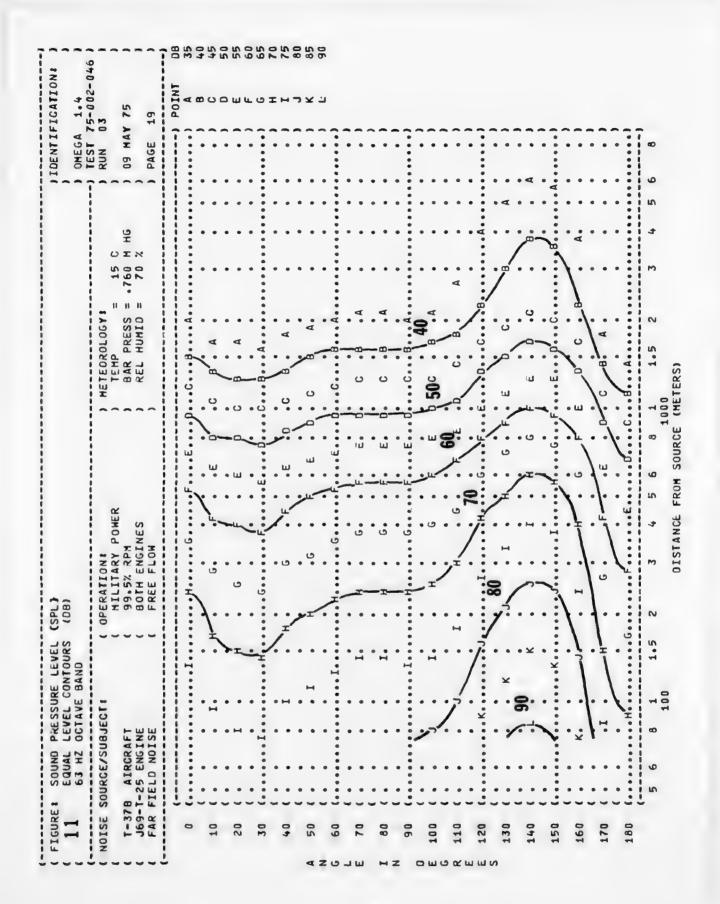


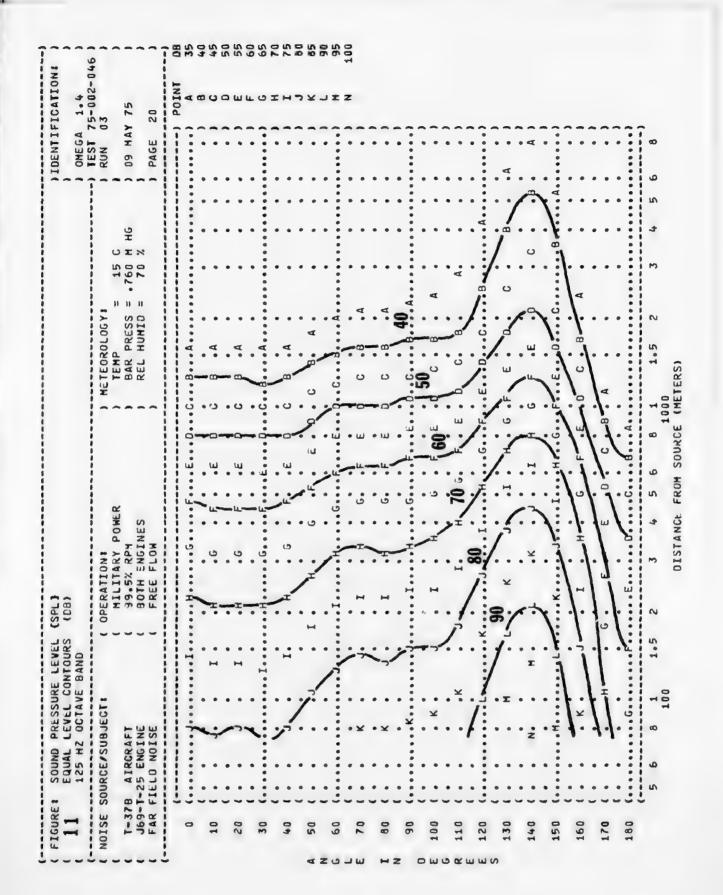


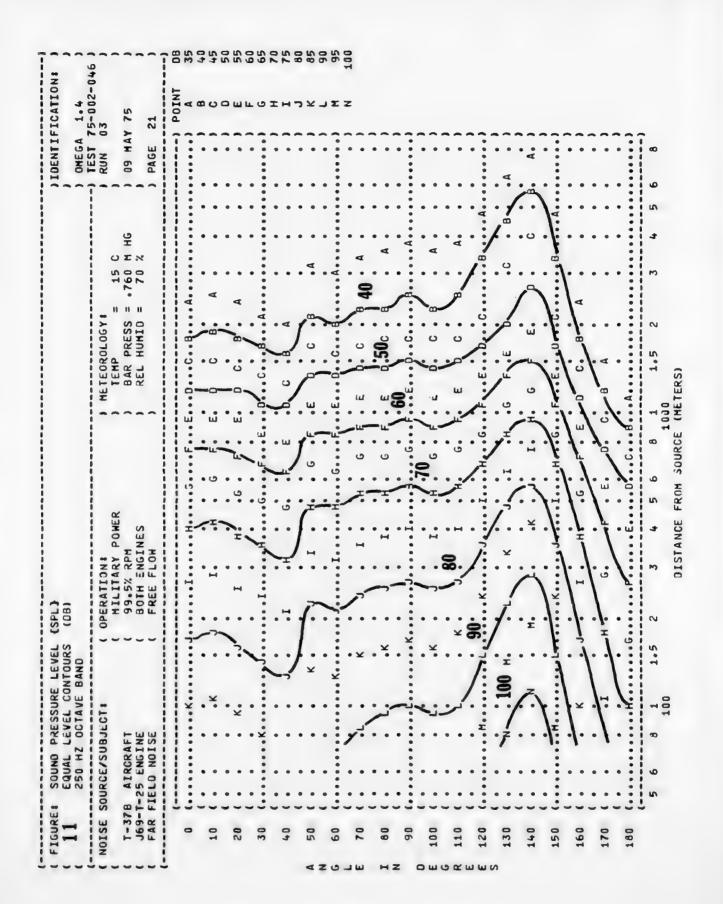
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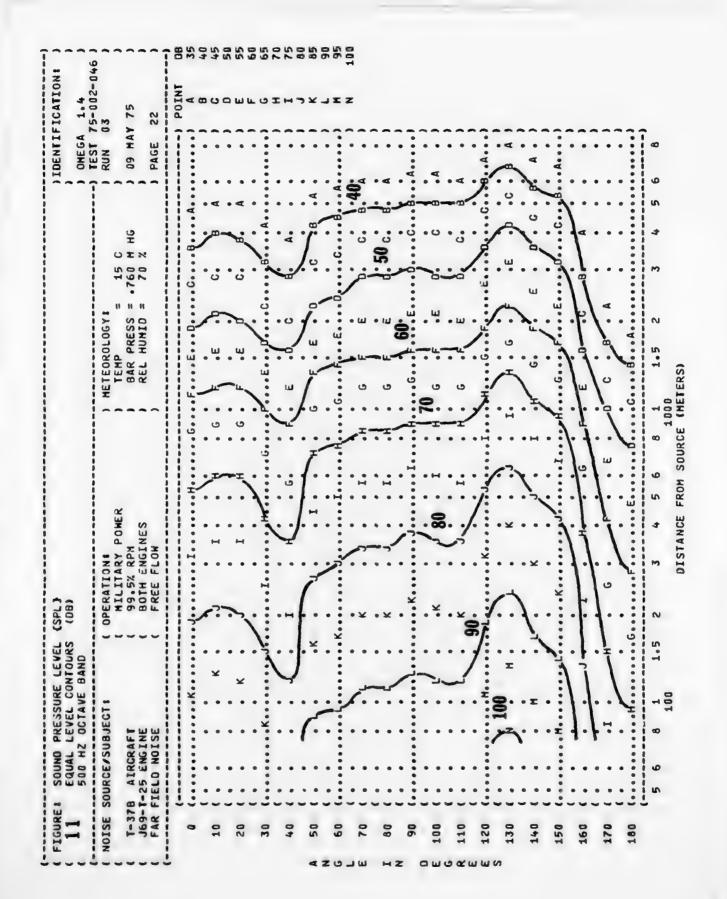
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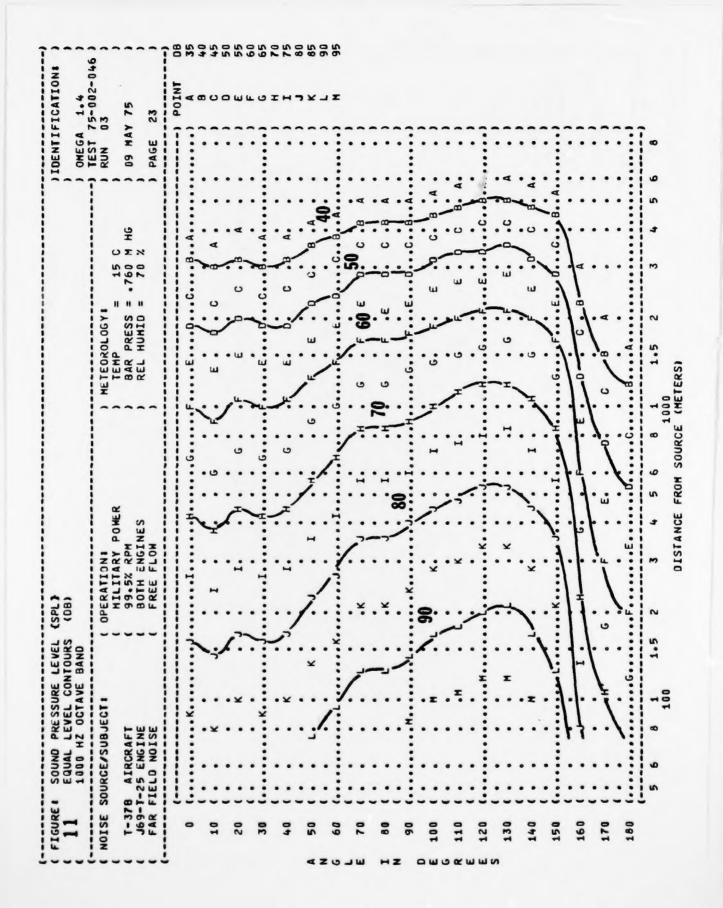


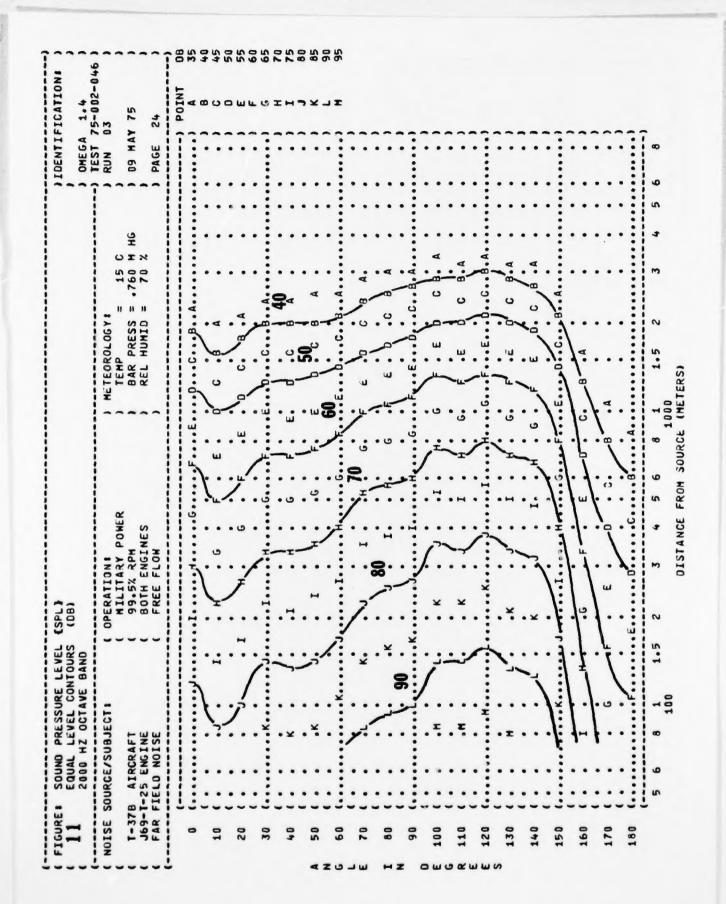


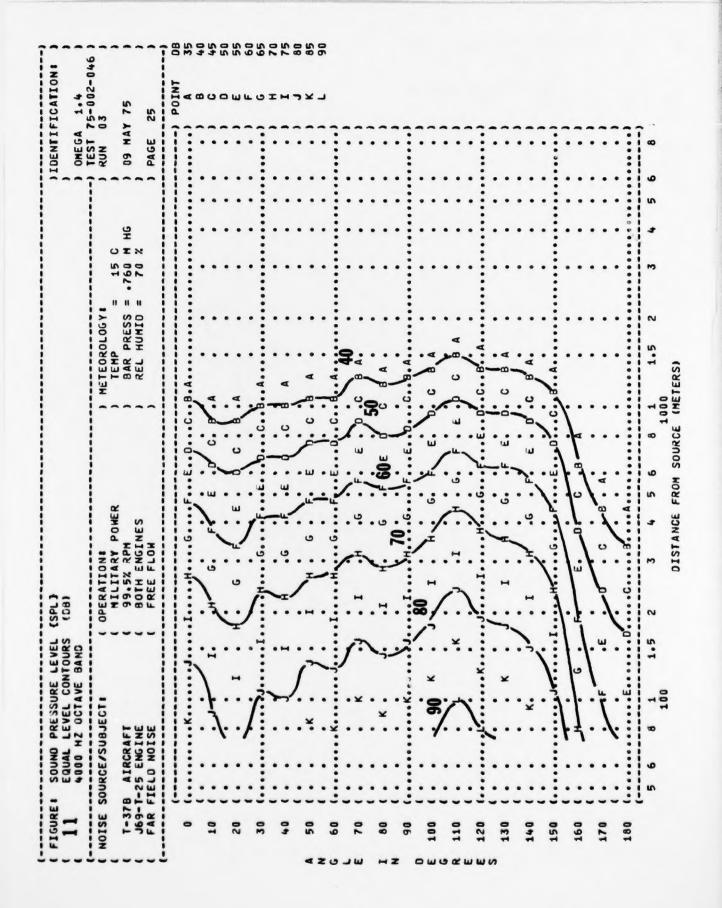












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